Fishery Data Series No. 06-54

A Mark–Recapture Study of Kuskokwim River Chinook, Sockeye, Chum, and Coho Salmon, 2005

Annual Report for Project FIS 04-308
USFWS Office of Subsistence Management, Fisheries Information Services Division

by

Jason Pawluk,

Jay Baumer,

Toshihide Hamazaki,

and

David Orabutt

October 2006

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$log_{2,}$ etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

FISHERY DATA SERIES NO. 06-54

A MARK–RECAPTURE STUDY OF KUSKOKWIM RIVER CHINOOK, SOCKEYE, CHUM, AND COHO SALMON, 2005

by
Jason Pawluk, Jay Baumer, Toshihide Hamazaki,
Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage

and

David Orabutt
Kuskokwim Native Association, Aniak

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518

October 2006

This investigation was partially financed by the U.S. Fish and Wildlife Service, Office of Subsistence Management (Project No. FIS 04-308) Fisheries Resource Monitoring Program under agreement number 701814J569.

The Division of Sport Fish Fishery Data Series was established in 1987 for the publication of technically oriented results for a single project or group of closely related projects. Since 2004, the Division of Commercial Fisheries has also used the Fishery Data Series. Fishery Data Series reports are intended for fishery and other technical professionals. Fishery Data Series reports are available through the Alaska State Library and on the Internet: http://www.sf.adfg.state.ak.us/statewide/divreports/html/intersearch.cfm This publication has undergone editorial and peer review.

Jason Pawluk, Jay Baumer, Toshihide Hamazaki,
Alaska Department of Fish and Game, Division of Commercial Fisheries,
333 Raspberry Road, Anchorage, AK 99518, USA

and

David Orabutt
Kuskokwim Native Association,
Aniak, AK 99557, USA

This document should be cited as:
Pawluk, J., J. Baumer, T. Hamazaki, and D. Orabutt. 2006. A mark–recapture study of Kuskokwim River Chinook, sockeye, chum and coho salmon, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-54, Anchorage.

The Alaska Department of Fish and Game (ADF&G) administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act (ADA) of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility please write:

ADF&G ADA Coordinator, P.O. Box 115526, Juneau AK 99811-5526

U.S. Fish and Wildlife Service, 4040 N. Fairfax Drive, Suite 300 Webb, Arlington VA 22203

Office of Equal Opportunity, U.S. Department of the Interior, Washington DC 20240

The department's ADA Coordinator can be reached via phone at the following numbers:

(VOICE) 907-465-6077, (Statewide Telecommunication Device for the Deaf) 1-800-478-3648, (Juneau TDD) 907-465-3646, or (FAX) 907-465-6078

For information on alternative formats and questions on this publication, please contact:

ADF&G, Sport Fish Division, Research and Technical Services, 333 Raspberry Road, Anchorage AK 99518 (907)267-2375.

TABLE OF CONTENTS

Page

LIST OF TABLES iii
LIST OF FIGURES iii
LIST OF APPENDICES iv
ABSTRACT 1
INTRODUCTION 1
Background 2
Targeted Species 2
Escapement Monitoring 3
Stock-specific Run Timing and Total Run Abundance Estimates 3
Kuskokwim River Salmon Mark–recapture Project 5
Objectives 6
METHODS 7
Study Design 7
Project Dates 7
Capture Methods 8
Fish Wheels 8
Drift Gillnets 8
Tag Deployment 9
Tag Recovery 9
Data Analysis 10
Data Entry 10
Stock-specific Run Timing 10
Travel Speed 10
Abundance Estimate Diagnostics 11
Abundance Estimate 11
RESULTS 11
Tag Deployment 11
Chinook Salmon 12
Sockeye Salmon 12
Chum Salmon 12
Coho Salmon 12
Tag Recovery 12
Chinook Salmon 13
Sockeye Salmon 13
Chum Salmon 13

TABLE OF CONTENTS (Continued)

Page

Stock-specific Run Timing 14
Chinook Salmon 14
Sockeye Salmon 14
Chum Salmon 14
Coho Salmon 14
Stock-specifc Travel Speed 14
Chinook Salmon 14
Sockeye Salmon 14
Chum Salmon 15
Coho Salmon 15
Abundance Estimate Diagnostics 15
Coho salmon Abundance Estimate 15
DISCUSSION 16
Tag Deployment and recovery 16
Run Timing 18
Travel Speed and Travel Days 21
Coho Salmon Abundance Estimate 22
CONCLUSIONS 24
RECOMMENDATIONS 24
ACKNOWLEDGMENTS 25
REFERENCES CITED 26
TABLES AND FIGURES 31
APPENDIX A 73
APPENDIX B 87
APPENDIX C 99
APPENDIX D. 105

LIST OF TABLES

Table **Page**

1. Distance to selected locations in the Kuskokwim River drainage. 32
2. Number of salmon anchor tagged at the Kalskag tagging site, 2005. 35
3. Number of anchor-tagged salmon recovered at escapement projects, 2005. 36
4. Number of anchor-tagged salmon recovered by subsistence, commercial, and sport fishers, 2005. 37
5. Stock-specific timing of anchor-tagged salmon at tributary escapement projects, 2005. 38
6. Stock-specific travel speed of anchor-tagged salmon, 2005. 39
7. Estimates of coho salmon abundance in the Kuskokwim River upstream of the Kalskag tagging site based on either tag recovery from gillnets and fish wheels near Aniak (wheel-to-wheel) or tag recovery from tributary escapement monitoring projects (wheel-to-weir). 40
8. Number of salmon examined for secondary marks at tributary escapement projects, 2005. 41
9. Contingency table analysis comparing marked to unmarked ratios of coho salmon counted at the Takotna, Kogrukluk, Tatlawiksuk, and George River weirs, 2005. 41
10. Estimates of salmon at various Kuskokwim River tributaries and statistics from the Kuskokwim River salmon mark–recapture project, 2001–2005. 42
11. Number of anchor-tagged salmon recovered at escapement projects by gear type used at the Kalskag site, 2005. 43

LIST OF FIGURES

Figure **Page**

1. Locations of tagging and weirs sites on the Kuskokwim River, 2005. 45
2. Location of fish wheels at tagging sites on the Kuskokwim River, 2002–2005. 46
3. Detailed map of 2005 fish wheel and drift gillnet locations. 47
4. Number of Chinook salmon tagged by date compared to the percent of Chinook salmon tagged at the Kalskag site on the Kuskokwim River, 2005. 48
5. Catch per hour of Chinook salmon from fish wheels (FW) and drift gillnets on the Kuskokwim River, 2005. 49
6. Number of sockeye salmon tagged by date compared to the percent of sockeye salmon tagged at the Kalskag site on the Kuskokwim River, 2005. 50
7. Catch per hour of sockeye salmon from fish wheels (FW) and drift gillnets on the Kuskokwim River, 2005. 51
8. Number of chum salmon tagged by date compared to the percent of chum salmon tagged at the Kalskag site on the Kuskokwim River, 2005. 52
9. Catch per hour of chum salmon from fish wheels (FW) and drift gillnets on the Kuskokwim River, 2005. 53
10. Number of coho salmon tagged by date compared to the percent of coho salmon tagged at the Kalskag site on the Kuskokwim River, 2005. 54
11. Catch per hour of coho salmon from fish wheels (FW) and drift gillnets on the Kuskokwim River, 2005. 55
12. Dates when Chinook salmon stocks monitored at tributary escapement projects pass through the Kalskag tagging site (rkm 271), based on Chinook tagged with (a) anchor tags only, (b) radio tags only, and (c) all tags combined. 56
13. Dates when individual Chinook salmon stocks pass through the Kalskag tagging site (rkm 271) based on radiotelemetry. 57
14. Dates when individual sockeye salmon stocks pass through the Kalskag tagging site (rkm 271) based on sockeye salmon tagged with anchor tags. 58
15. Dates when individual chum salmon stocks pass through the Kalskag tagging site (rkm 271) based on chum salmon tagged with anchor tags. 59
16. Dates when individual coho salmon stocks pass through the Kalskag tagging site (rkm 271) based on coho salmon tagged with anchor tags. 60

LIST OF FIGURES (Continued)

Figure **Page**

17. Travel speed (rkm/day) of both anchor- and radio-tagged Chinook salmon from the Kalskag site to the George, Tatlawiksuk, Kogrukluk, and Takotna River weirs on the Kuskokwim River, 2005. 61
18. Travel speed (rkm/day) of anchor-tagged sockeye salmon from the Kalskag site to the George, Tatlawiksuk, Kogrukluk, and Takotna River weirs on the Kuskokwim River, 2005. 62
19. Travel speed (rkm/day) of anchor-tagged chum salmon from the Kalskag site to the George, Tatlawiksuk, Kogrukluk, and Takotna River weirs on the Kuskokwim River, 2005. 63
20. Travel speed (rkm/day) of anchor-tagged coho salmon from the Kalskag site to the George, Tatlawiksuk, Kogrukluk, and Takotna River weirs on the Kuskokwim River, 2005. 64
21. Daily effort in minutes for drift gillnetting on the Kuskokwim River, 2005. 65
22. Proportion of recaptures of Chinook salmon tagged at the Kalskag site by gear type and recovered at upstream escapement projects on the Kuskokwim River, 2005. 66
23. Proportion of recaptures of sockeye salmon tagged at the Kalskag site by gear type and recovered at upstream escapement projects on the Kuskokwim River, 2005. 66
24. Proportion of recaptures of chum salmon tagged at the Kalskag site by gear type and recovered at upstream escapement projects on the Kuskokwim River, 2005. 67
25. Proportion of recaptures of coho salmon tagged at the Kalskag site by gear type and recovered at upstream escapement projects on the Kuskokwim River, 2005. 67
26. Kuskokwim River tributary coho salmon escapement compared to two types of coho abundance estimates conducted on the mainstem Kuskokwim River, 2001–2005. 68
27. A comparison by year of coho abundance estimates using wheel-to-weir or wheel-to-wheel data sets with their respective 95% confidence intervals. 69
28. Water levels at the Crooked Creek gauging station, on the mainstem Kuskokwim River, 2001–2005. 70
29. The linear relationship between coho salmon abundance estimates (from wheel-to-wheel or wheel-to-weir data sets) to the median weir index by year 71

LIST OF APPENDICES

Appendix **Page**

A1. Daily summary of tagged, untagged, and recaptured Chinook salmon at the Kalskag site on the Kuskokwim River, 2005 74
A2. Daily summary of tagged, untagged, and recaptured sockeye salmon at the Kalskag site on the Kuskokwim River, 2005 77
A3. Daily summary of tagged, untagged, and recaptured chum salmon at the Kalskag site on the Kuskokwim River, 2005 80
A4. Daily summary of tagged, untagged, and recaptured coho salmon at the Kalskag site on the Kuskokwim River, 2005 83
B1. Tags observed and recovered by date at the Takotna River weir, 2005. 88
B2. Tags recovered and observed by date at the Kogrukluk River weir, 2005. 90
B3. Tags observed and recovered by date at the Tatlawiksuk River weir, 2005 92
B4. Tags observed and recovered by date at the George River weir, 2005 94
B5. Tags observed and recovered by date at the Aniak River sonar site, 2005 96
C1. Number of recovered tags from Chinook salmon by subsistence, commercial, and sport fishing, at locations downstream and upstream from the Kalskag tagging site on the Kuskokwim River, 2005. 100
C2. Number of recovered tags from sockeye salmon by subsistence, commercial, and sport fishing, at locations downstream and upstream from the Kalskag tagging site on the Kuskokwim River, 2005. 101
C3. Number of recovered tags from chum salmon by subsistence, commercial, and sport fishing, at locations downstream and upstream from the Kalskag tagging site on the Kuskokwim River, 2005 102
C4. Number of recovered tags from coho salmon by subsistence, commercial, and sport fishing, at locations downstream and upstream from the Kalskag tagging site on the Kuskokwim River, 2005 103
D1. Escapement goal for Kuskokwim River Coho salmon (run reconstruction). 106

ABSTRACT

Anchor tags were deployed on Chinook *Oncorhynchus tshawytscha*, sockeye *O. nerka*, chum *O. keta*, and coho *O. kisutch* salmon caught in the mainstem Kuskokwim River and recovered at several upstream tributaries to determine stock-specific run timing and stock-specific travel speed, and to estimate total coho salmon run abundance using a two-sample mark–recapture design. Fish were captured near Kalskag using fish wheels and drift gillnets, and then fitted with uniquely numbered anchor tags. Tags were then recovered, or at least observed, at 5 upstream tributary escapement projects (Takotna, Tatlawiksuk, Kogrukluk, and George river weirs, and Aniak River sonar), plus recoveries were made from carcass surveys conducted in selected tributaries and from opportunistic voluntary tag returns. Tag deployment in 2005 included 1,198 Chinook, 4,648 sockeye, 28,416 chum, and 5,512 coho salmon. Subsequent recovery of the unique tag numbers from the 5 upstream tributary projects included 129 Chinook (11%), 234 sockeye (5%), 624 chum (2%), and 322 coho salmon (6%), plus total observed tags for coho salmon was 338 fish, inclusive of recovered tags. Tags were also recovered from carcass surveys in Oskawalik River and Telaquana Lake, which added to the analysis of stock-specific run timing. Overall, salmon run timing past Kalskag was earliest for stocks traveling to tributaries farthest upstream and progressively later for stocks traveling to less distant tributaries, which is consistent with findings from previous years. Average stock-specific travel speed was greatest for salmon traveling farthest upstream, and progressively slower for fish traveling to less distant tributaries. In addition, the travel speed of Chinook and coho salmon tended to increase relative to the tagging date as the season progressed, with fish tagged early in the season traveling slower than fish tagged later in the season. Coho salmon abundance upstream from Kalskag in 2005 was estimated to be 640,736 fish (95% CI=547,011 to 746,953; SE=52,541) using the Chapman estimator. This project also served as a platform in support of radiotelemetry studies focused on Chinook salmon, sockeye salmon, and broad whitefish Coregonus nasus, which are described in separate reports.

Key words: Kuskokwim River abundance estimate, Chinook salmon, *Oncorhynchus tshawytscha*, chum salmon, *O. keta*, coho salmon, *O. kisutch*, , mark–recapture, run timing, stock-specific, sockeye salmon, *O. nerka*, tagging, travel speed.

INTRODUCTION

Kuskokwim River salmon stocks have been challenging to manage in part because numerous stock assemblages occur among the different species and they overlap in run timing; plus the drainage is large, remote, and geographically diverse. Although the river is the second largest in Alaska (Moody et al. 1986), and supports one of the largest and most important subsistence fisheries in the state (ADF&G 2001a, 2002, 2003a, 2003b), research and management tools have been limited. A subsistence fishery occurs along nearly 1,174 river km (rkm) and includes approximately 1,011 households from 29 communities. Commercial fishing occurs in the lower 203 rkm of the Kuskokwim River where 840 permits were issued under the state's limited entry program. Salmon spawn in over 28 navigable tributaries (Brown 1983) including the Kialik River, which is 3 km from the Kuskokwim River mouth to the uppermost headwaters approximately 1,548 rkm away (Whitmore et al. 2005).

Ideally, fishery managers have preseason knowledge of salmon run abundance and can accurately assess stock-specific run strength and timing. From that knowledge they identify if there is a harvestable surplus above spawning requirements, provide for the priority use of subsistence fishers throughout the drainage, and allow any remaining surplus to be allocated to other fishers (sport, commercial, and personal use). Within the Kuskokwim River, the challenge to sustain fisheries for all users is made difficult by the gauntlet nature of the subsistence and commercial fisheries in the lower river, the necessity to spread harvest opportunity over much of the river, and the potential of differential exploitation especially between upper and lower river stocks. Currently, fishery managers do not forecast run abundance, monitor total abundance in season, or have sufficient knowledge of run timing differences among stocks in the mainstem

Kuskokwim River to evaluate the need to selectively target or protect individual stocks. Decisions to open and close fisheries are instead based on a gillnet test fishery operated near Bethel, catch trends from commercial and subsistence fisheries, and select tributary escapement counts (Whitmore et al. 2005). Escapement requirements according to the state's Policy for Statewide Salmon Escapement Goals (5 AAC 39.223) have been determined for 9 spawning locations for Chinook salmon *Oncorhynchus tshawytscha*, 2 spawning locations for chum salmon *O. keta*, and1 spawning location for coho salmon *O. kisutch* for the entire Kuskokwim River drainage (ADF&G 2004). No escapement requirements are currently in place for sockeye salmon *O. nerka*. Current escapement goals are ranges representing the 15th (or 25th) to 75th (or 85th) percentile of escapements observed for each system with the actual percentile chosen based on data contrast and assumed level of exploitation (Bue and Hasbrouck 2001). Since catch by stock is unknown, traditional spawner-recruit analyses are not possible for individual tributaries.

To meet the challenge of sustainable management of salmon fisheries in the Kuskokwim River, drainage-wide abundance and stock-specific migratory timing is needed. Abundance estimates are needed preseason, inseason, and as representative of actual spawning abundance (i.e. total abundance minus total harvest equals spawning escapement). Drainage-wide abundance, when coupled with a drainage-wide escapement goal, would allow managers to identify a harvestable surplus. Stock-specific migratory timing information is also needed to evaluate stock timing differences and to determine if stocks may be differentially harvested through time. Harvest strategies must be evaluated and exploitation rates calculated. A goal of sustainable management is to include escapement counts with adequate distribution throughout the drainage.

This project is a continuation of a project that began in 2001. It was designed to provide additional information useful for managing the fisheries by using mark–recapture techniques in the Kuskokwim River, upstream from Kalskag, to estimate run timing of specific monitored stocks of Chinook, sockeye, chum, and coho salmon, and to estimate total abundance of coho salmon. Fish wheels and drift gillnets were used near Kalskag to capture adult salmon for marking. Marked fish were recovered at upriver tributary escapement projects (Figures 1 and 2). Use of uniquely numbered anchor tags provided information on migratory timing and travel speed in the mainstem for salmon stocks spawning in tributaries with escapement monitoring projects.

BACKGROUND

The following narrative reviews the background and history of Kuskokwim River Chinook, sockeye, chum, and coho salmon mark–recapture/tagging experiments, current methods used to evaluate escapement, and the results and present funding status of the Kuskokwim River tagging project.

Targeted Species

Chum salmon is the second most important species in the commercial and subsistence harvest (Coffing et al. 2001; Whitmore et al. 2005). Coho salmon is the most important commercial species and Chinook salmon is the most important subsistence species. In 2000, Kuskokwim River Chinook and chum salmon were listed as stocks of concern under the Policy for Management of Sustainable Salmon Fisheries (5 AAC 39.222) because of the chronic inability of managers to maintain expected harvest and escapements levels (Burkey et al. 2000). Commercial fishing had been closed for chum salmon since 1999 and for Chinook salmon since 1991, plus a subsistence fishing schedule was established in 2001 that required 3 consecutive days to be

closed to fishing per week. The continued stock of concern status for both Chinook and chum salmon was reaffirmed in 2004 (Bergstrom and Whitmore 2004), although runs have improved since 2001 and commercial fishing for chum salmon was allowed again in 2004. Coho salmon were not identified as a formal stock of concern, however, the United States Congress identified Kuskokwim River coho salmon in the fishery disasters declared in 1997 and 1998. Additionally, sockeye salmon were not listed as a stock of concern, but escapement levels for these species are virtually unknown and remain a concern to managers due to recent increased interest in the commercial and subsistence use of sockeye salmon. In fact, in 2004 the Alaska Board of Fisheries approved a sockeye salmon guideline harvest limit of 0 to 50,000 fish (Whitmore et al. 2005)

Escapement Monitoring

Weirs are currently operated on 6 major tributaries of the Kuskokwim River to monitor salmon escapement and a sonar project is operated on a seventh (Figure 1). A weir on the Kogrukluk River indexes the Holitna River stock, and has annual escapement data dating back to 1976 (Baxter *Unpublished*; Jasper and Molyneaux *In prep*). The Kogrukluk River weir is approximately 219 rkm upriver from the mouth of the Holitna River and 710 rkm from the mouth of the Kuskokwim River. Adult salmon take approximately 3 to 4 weeks to travel to the weir from the mouth of the Kuskokwim River. The Kogrukluk River drainage is the only system with a weir-based escapement goal for chum, coho, and Chinook salmon; however, its value to managers for opening and closing fisheries is limited during the early portion of each run because of the protracted lag time between when this spawning stock travels through commercial and subsistence fisheries to when they pass the weir. Since the mid 1990s, 5 additional weirs were established to better quantify escapement and run strength. These weirs are located on the following tributaries: Kwethluk River (Roettiger et al. 2005), Tuluksak River (Zabkar et al. 2006), George River (Stewart et al. *In prep*), Tatlawiksuk River (Costello et al. 2006b), and Takotna River (Costello et al. 2006a). A sonar project on the Aniak River is used to index chum salmon escapement during late June and July when this species dominates, and a sonar-based escapement goal has been established for chum salmon in the Aniak River (McEwen *In prep*).

Recently, escapement monitoring projects using radiotelemetry techniques were established to study Chinook, chum, and coho salmon in the Holitna River drainage and Chinook salmon in the Kuskokwim River, upstream from Kalskag. The radiotelemetry study for the Holitna was initiated in 2001 (Chythlook and Evenson 2003) to estimate Chinook, chum, and coho abundance and the percent monitored by the Kogrukluk weir. In 2003, coho salmon were eliminated from the study (Stroka and Brase 2004) and only Chinook and chum abundance was estimated. The project ended with the estimation of abundance of Chinook and chum salmon in 2004 (Stroka and Reed 2005). A project to estimate abundance of Chinook salmon in the Kuskokwim River, upstream of Kalskag began in 2002 (Stuby 2005).

Stock-specific Run Timing and Total Run Abundance Estimates

For many years researchers and managers recognized the importance of stock-specific run timing information and total run abundance estimates for adult salmon returning to spawn. Numerous tagging projects have been conducted on large river systems such as the Kuskokwim and Yukon rivers where gauging run strength is complex. Early mainstem tagging projects on the Kuskokwim and Yukon rivers were not designed to estimate abundance and had limited success. In the 1960s, tagging studies were conducted on the Kuskokwim River (ADF&G 1961a, 1962,

1966) and the Yukon River (ADF&G 1961b, Lebida 1969, Regnart 1962, 1964), and again in the Kuskokwim River in 1989 (Marino and Otis 1989). Distance traveled by tagged fish and the number of days between release and recapture were calculated from these data, but stock-specific information was lacking. The primary deficiencies of these studies were the inability to tag adequate numbers of fish and the absence of tributary projects to recover tags. No stock-specific mark and recovery data were available. The greatest number of tags deployed during this period was 362 Chinook salmon tags on the Kuskokwim River (ADF&G 1966).

More recently, researchers tried to characterize run timing differences among chum salmon stocks in the Kuskokwim River. In 1995, the Bering Sea Fishermen's Association funded a radiotelemetry study for chum salmon (Parker and Howard 1995) with the objective of identifying temporal differences in stock-specific run timing as they passed through the lower river commercial fishing districts. The project fell short in reaching this objective because, among other factors, too few chum salmon were tagged and receiver stations failed.

Estimating stock-specific run timing has been successfully demonstrated elsewhere on returning adult Chinook and sockeye salmon. In the Copper River, individual stocks of Chinook salmon were found to have different mean dates of passage that were maintained over the study (Savereide 2004). From 1996 to 2001, Keefer et al. (2004) were able to differentiate between 38 spatially separated stocks of Chinook salmon in the Columbia River Basin by median dates of passage using radio tags. Stock-specific run timing was also investigated for sockeye salmon from the Frasier River system (Killick 1955), Bristol Bay (Jensen and Mathisen 1987; Rowse 1985), and the Copper River drainage (Merritt and Roberson 1986). Consistent differences in timing and migration rate among sockeye stocks of the Frasier River have been observed from the location of fisheries to the time of spawning (Killick 1955). In contrast, such chronological separations have not been as clear in Bristol Bay sockeye runs (Groot and Margolis 1991). Merritt and Roberson (1986) found earlier migrating sockeye stocks demonstrated a greater consistency of timing between years than later migrating stocks.

Improvements in tagging techniques, fish handling and capture gear, coupled with advances in estimation modeling and model testing (Schwarz and Seber 1999) allow researchers to effectively estimate the population size of adult salmon migrating up large rivers. From 1982 to 1985 on the Susitna River, Barrett et al. (1984a, 1984b) demonstrated that large numbers of adult salmon could be tagged and recovered using fish wheels, supplemented by tributary monitoring for mark to unmarked data. Population estimates were calculated for Chinook salmon in the lower Yukon River (Spencer et al. 2002) and the Yukon River at the border with Canada (Johnson et al. 2002), Keta River (Brownlee et al. 1999), Kenai River (Hammarstrom and Hasbrouck 1998, 1999), Taku River (McPherson et al. 1998), Stikine River (Der Hovanisian et al. 2003), Copper River (Evenson and Wuttig 2000), and recently the Holitna River (Stroka and Reed 2005) and Kuskokwim River above Kalskag (Stuby *In prep*). Chum salmon abundance was estimated for the upper Tanana River (Cappiello and Bromaghin 1997; Cappiello and Bruden 1997; Cleary and Bruden 2000; Cleary and Hamazaki 2002), the upper Yukon River (Underwood et al. 1998), and the Yukon River at the border with Canada (JTC 2002). These Yukon River projects provide inseason estimates of chum salmon abundance and use fish wheel release and recovery methods. Coho salmon abundance has been estimated using mark–recapture techniques on the Kenai River (Carlon 2000), Chilkat River (Ericksen 1999), Steep Creek (Jones III and McPherson 1997), Unuk River (Jones III et al. 2001), and Holitna River (Chythlook and

Evenson 2003; Stroka and Brase 2004; Wuttig and Evenson 2002). This list is not meant to be exhaustive, but reflective of the successful application of the technique in large rivers in Alaska.

Kuskokwim River Salmon Mark–recapture Project

Following declaration of the 1997 and 1998 fisheries as disasters in Bristol Bay, and in the Kuskokwim and Yukon rivers, Congress appropriated $7 million to develop a disaster research and prevention plan. The resulting Western Alaska Salmon Fisheries Disaster Mitigation Research Plan (WASFDP) recognized the critical importance of healthy western Alaska salmon runs to area residents (ADF&G 1999). Chum, Chinook, and coho salmon of the Kuskokwim River were all considered vitally important. Through the WASFDP grant, $495,000 was awarded to the Alaska Department of Fish and Game (ADF&G) to specifically estimate abundance and migratory timing characteristics of Kuskokwim River coho salmon using mark–recapture techniques.

The WASFDP was revised in 2001 and redirected Kuskokwim River mainstem sonar project funds (Eggers 2001) toward additional mark–recapture studies for Chinook, chum, and sockeye salmon. These species were included because of their importance to subsistence and commercial fishers, their recent declines in abundance, and the shortage of information available to fisheries managers. ADF&G, Division of Sport Fish, has been responsible for estimating the abundance of Chinook salmon in the mainstem, and the Division of Commercial Fisheries has been responsible for chum, coho, and sockeye salmon. In 2002, the state's general funds designated for the Kuskokwim River sonar were redirected to support the coho, sockeye, and chum salmon mark–recapture project. In June of 2003, funding from the WASFD grant ended, but replacement funds were awarded through the Arctic-Yukon-Kuskokwim Sustainable Salmon Initiative (AYK-SSI) and United States Fish and Wildlife Service (USFWS) Office of Subsistence Management (OSM). In 2004, funds awarded through AYK-SSI were discontinued, but a multi-year grant was awarded through the USFWS OSM Fisheries Resource Monitoring Program (project FIS 04-308).

The first year of operation (2001) assessed the feasibility of the project and focused on coho salmon. ADF&G and the Kuskokwim Native Association worked together to design and construct 4 fish wheels, select fish wheel sites for tag deployment near Kalskag, select fish wheel sites for tag recovery and additional tag deployment near Aniak, select field campsites, and organize logistics for tag recovery. In this feasibility year, the investigators successfully tested various fish wheel sites, configurations, and gillnet drift locations (Kerkvliet and Hamazaki 2003). They investigated tag recovery methods both at the fish wheel tag recovery platform near Aniak and at weir sites upstream of the tagging site, plus they conducted a tag recovery lottery. A coho salmon abundance estimate, which was the primary objective, was not calculated from the Kalskag fish wheel to Aniak fish wheel data set because of low tag recoveries. Nor was an abundance estimated calculated from the pooled Kalskag/Aniak tag deployment to weir-tag recovery data set because recovery rates were significantly different among weir recapture sites. Run timing results using cumulative percentage of recovered coho salmon above the tag sites suggested fish entering the river early enter tributaries farthest upstream and later entering fish entered tributaries progressively farther downstream. This result supported Traditional and Ecological Knowledge (TEK) from local residents. Differences in travel time were also detected from tag recoveries at escapement projects, with a significant difference in travel speed occurring between coho salmon tagged earlier, which traveled slower, than those tagged later in the run.

In 2002 and 2003, the scope of the project increased to include sockeye and chum salmon (Kerkvliet et al. 2003, 2004). Low numbers of sockeye salmon captures resulted in the inability to recover adequate numbers of tagged salmon to estimate the population size in 2002. However, in 2003 enough sockeye salmon were tagged and recaptured to estimate abundance upstream of Kalskag as 90,449 sockeye salmon (95% CI=54,842; 126,056). Temporal differences in tag recovery were observed at the Aniak tag recovery site from 2002 to 2004 for coho salmon and 2002 to 2003 for chum salmon; however, data were stratified through time and abundance estimated using the Darroch estimator (Seber 1982). The population estimate of chum salmon upstream from Kalskag in 2002 was 675,659 (95% CI=559,564; 791,755) and in 2003 was 412,443 (95% CI=351,765; 473,121). The population estimate of coho salmon upstream from Kalskag in 2002 was 316,068 (95% CI=193,877; 438,259), in 2003 was 849,494 (95% CI=654,182; 1,044,806), and in 2004 was 386,743 (95% CI=303,995; 469,491). In 2004, efforts to estimate abundance for sockeye and chum salmon were abandoned due to funding shortfalls, and instead resources were focused on estimating coho salmon abundance, stock-specific run timing, and stock-specific travel speed (Pawluk et al. 2006).

From 2001 to 2004, stock-specific run timing results using cumulative percentages of tagged sockeye, chum, and coho salmon recovered at escapement projects indicated fish tagged earlier traveled to tributaries further upstream, and that fish tagged later in the season traveled to tributaries progressively farther downstream (Kerkvliet et al. 2003; 2004; Pawluk et al. *In prep*). This pattern was most prominent for chum salmon. Furthermore, from 2002 to 2004, data showed that chum and coho salmon traveling speed increased as distance from the tag site increased. In addition to tagging sockeye, chum, and coho salmon, the Kuskokwim River tagging study serves as a platform for other projects involved in research of Kuskokwim River fish. A radiotelemetry study has been conducted on Chinook salmon by ADF&G, Division of Sport Fish, since 2002, using drift gillnets with catches supplemented by fish wheel caught Chinook (Stuby 2005). Another study was conducted in 2004 by ADF&G, Division of Commercial Fisheries, involving sampling chum salmon to determine the composition and run-timing of fall chum salmon passing by the fish wheels (Gilk et al. 2005). In 2005, a pilot study involving radio-tagging sockeye salmon was conducted using catches from the fish wheels and gillnets (Gilk *Unpublished*). Whitefish have also been sampled by the USFWS from the fish wheels for age, sex, and length information, gonadosomatic indexing analysis, catch indexing, tag recovery, and radio tag deployment in broad whitefish (Harper et al. *In prep*).

OBJECTIVES

The 2005 project was again redesigned to address reduced funding and in response to site selection issues in 2004. Tagging and tag recovery near Aniak was discontinued, and we instead focused on tag deployment at the Kalskag site with recaptures at tributary escapement projects. In 2005, tagging of sockeye and chum salmon continued, plus we began anchor-tagging Chinook salmon to estimate run timing and mean travel speed. The coho salmon tagging that was performed in 2005 was funded by a surplus in the State of Alaska general funds that were identified during the third quarter audit, and it was a one-time opportunity for conducting the mark–recapture abundance estimate. The 2005 objectives, modified to provide managers a tool in making informed decisions toward sustainable fisheries management, were to:

1. Describe stock-specific run timing past Kalskag (rkm 270) for selected spawning aggregates of Kuskokwim River Chinook, chum, and sockeye salmon.

2. Characterize stock-specific travel speed dynamics for selected spawning aggregates of Kuskokwim River Chinook, chum, and sockeye salmon traveling between Kalskag (rkm 270) and their respective spawning grounds.
3. Provide a platform for other projects:
    - Chinook radiotelemetry (FIS 02-015)
    - Sockeye radiotelemetry (pilot study 2005)
    - Whitefish radiotelemetry (FIS 04-304)
4. Estimate abundance of coho salmon in the Kuskokwim River passing upstream of Kalskag (rkm 270) between June 1 and September 8, with a relative precision (coefficient of variation) of +/- 20% or less.

METHODS

STUDY DESIGN

This study was designed to use mark–recapture methods to estimate stock-specific run timing and travel speed of Chinook, sockeye, chum, and coho salmon, and to estimate the population size of coho salmon upstream of Kalskag. Anchor tags were deployed on fish caught in fish wheels and gillnets operated on the main stem Kuskokwim River near Kalskag (270 rkm) from June 1 to September 9. Tags were recovered throughout the operational period of tributary escapement projects located upstream of the tagging site (Figure 1). The distance between the tag deployment site and the various upstream tag recovery sites was as follows: 565 rkm to Takotna River weir, 440 rkm to Kogrukluk River weir, 298 rkm to Tatlawiksuk River weir, 183 rkm to George River weir, and 53 rkm to Aniak River sonar (Table 1). In addition, opportunistic voluntary tag recoveries were received from several other tributaries, as well as tags recovered during carcass surveys.

The general location used for tag deployment was selected because: (1) it was far enough removed from marine waters to where the salmon were expected to be physiologically more tolerant of capture and tagging stress, (2) incidental harvest of tagged fish would be reduced, because location was upstream of the commercial fishing district and most subsistence fishing, (3) it was below most salmon spawning streams, (4) water velocity was known to be adequate for fish wheel operation, (5) the distance between the tag deployment and the recovery sites was far enough to reasonably assume that tagged fish would mix with untagged fish, and (6) the location was used successfully during 2001–2003. As to this later point, the Lower Kalskag tag deployment site used in 2004 was unsuccessful due to low catch rates and low water velocity, which prompted a return to the location used in previous years (Figure 2; Pawluk al. *In prep*). In response to reduced funding, we discontinued use of the Aniak tag recovery site used to sample from 2001 to 2004.

PROJECT DATES

The start and end dates of field operations were selected to ensure sampling occurred throughout the migration of Chinook, sockeye, chum, and coho salmon past the Kalskag fish wheel site. The start date at the Kalskag site needed to be prior to significant passage of Chinook, sockeye, and chum salmon whose run timing precedes that of coho salmon. Based on previous year's catches and the shared platform for radio-tagging Chinook salmon, we planned to start fishing on June 1.

The end date for field operations was selected to sample coho salmon near the end of the run, while allowing ample time for coho salmon to reach upstream escapement projects. Researchers are aware that estimating the entire coho salmon return was unrealistic because coho salmon continue their migration into the fall, perhaps even after the river has froze, which is a typical characteristic for coho salmon (Carlon 2000; Ericksen 1999; Jones III and McPherson 1997; Jones III et al. 2001). However, estimating coho salmon stocks vulnerable to harvest was considered an achievable goal. To this end, we selected a project end date of September 8 at the Kalskag site to encompass coho salmon stocks vulnerable to harvest by considering ending dates at upriver escapement projects, travel speed, and harvest pressures. Upriver weir operations generally cease by September 20 because it is thought most of the coho salmon escapement has been counted by that time. In years when weirs have operated beyond September 20, the counts of coho salmon have accounted for only 0.1% to 2.1% of the return (Ward et. al. 2003).

CAPTURE METHODS

Fish Wheels

Three fish wheels were used to capture salmon at the Kalskag site in 2005. Two fish wheels were located on the right bank[1] and a third on the left bank (Figure 3). This was a modification from prior years when only 2 fish wheels were used near Kalskag. All wheels were located 7 to 11 rkm upstream of Kalskag (270 rkm). Each fish wheel consisted of 3 aluminum capture baskets measuring 2.4 by 3.0 m (length, width), a perforated plywood live box measuring 2.4 by 1.2 by 0.6 m (length, width, depth) attached to the offshore side of each wheel, and a weir measuring 5 m (length) positioned perpendicular to the bank that served as a lead from shore to the fish wheel.

Fish wheels were operated continuously, except for periods of maintenance, readjustment, or relocation. Crews consisting of 2 people worked alternating 7.5-hour shifts each day to anchor-tag salmon. During each shift, a crew tagged fish from each wheel approximately every 2 hours, depending on catch rates. Between shifts, however, fish were held longer than 2 hours. Initially, 2 shifts ran from 0600 to 1400 hours and from 1800 to 0200 hours. As the season progressed and daylight hours shortened, the schedule was progressively adjusted until by the end of the season they ran from 0700 to 1500 hours and 1700 to 0100 hours.

Drift Gillnets

Salmon migrating off shore from the fish wheels were captured and tagged using drift gillnets. Nets were fished between fish wheel checks for a total of 2 hours of actual drift time per day. The gillnets had 4-in mesh (10.16 cm) hung at a ratio of 4 to 1 to allow the nets to function as "tangle" nets that would minimize physical harm to the fish. Gillnets were 45 meshes deep and either 5 or 10 fathoms in length. The net length used was based on catch rates, with 5-fathom nets fished when catch rates were high, and the 10-fathom net when catches were low. Crews deployed the nets from an 18 or 20 ft skiff, and immediately retrieved the net at the first sign that a fish was entangled. Salmon that appeared healthy were freed from the net and lifted into the skiff where they were placed into a tub of fresh river water, then tagged, and released. Salmon that escaped, were spawning, were injured, or otherwise considered unhealthy were released without tagging.

---

[1] "Right" and "left" bank are defined from the orientation of facing downstream.

TAG DEPLOYMENT

Tagging consisted of one primary and one secondary mark, with the primary mark being an 11-cm Floy® T-bar Anchor Tag (model FD-68BC)[2] made with monofilament and plastic tubing. Each anchor tag had a unique identification number and the phone number of the ADF&G Anchorage office. Three tag colors were deployed: fluorescent pink for salmon caught in right bank fish wheels, fluorescent green for salmon caught in the left bank fish wheel, and yellow for salmon caught in drift gill nets. Each tag was inserted into the back of the fish just below the base of the dorsal fin and about 4 rays up from the posterior end of the dorsal fin on either the left or right side. The tag was inserted using a tag gun with a 4 cm long needle and lever release. Each fish also received a secondary mark that consisted of removal of the adipose fin using a deer skinning or "zip" knife. Secondary marks were used to assess tag loss. Non-target species and salmon not tagged were identified, counted, and then released without marking.

Salmon selected for tagging were placed into a padded aluminum cradle that was suspended in a tub filled with river water. Fresh river water was constantly being pumped into the holding tub. Data collected on each tagged fish consisted of fish condition and fish color, which were based on a scale from 1 to 4. Fish color indicated spawning condition (i.e., bright, some color, obvious color, spawning color), and fish condition indicated fish health (i.e., good, minor wound, major wound, dead). Fish length, sex, and scales were not collected, although this information was collected in some previous years. All Chinook, sockeye, chum, and coho salmon were tagged with the exception of fish that escaped during handling, were determined unhealthy, or were spawned out.

TAG RECOVERY

Most tag recovery occurred at the 6 tributary escapement projects described earlier (Figure 1). At the 5 weirs, tag recovery was accomplished through the use of fish traps operated throughout the season. On the Aniak River, however, tags were recovered opportunistically from fish caught with beach seines fished weekly by the Aniak sonar crew who were primarily focused on collecting chum salmon age, sex, and length (ASL) information. In past years, beach seining ended by late July when the sonar project ended, but in 2005 beach seining was scheduled to continue through September 20 solely for tag recovery. At all escapement projects, tagged fish were described as "recovered" when crews were able to actually capture the fish, and record the tag number and recovery date. Alternatively, tagged fish were described as "observed" when crews could not capture the fish, but were able to record tag color and date observed.

Tag loss was assessed at the weir sites by inspecting fish during routine ASL sampling, which was augmented for coho salmon by additional sampling focused solely on inspection of tag loss. An anchor tag was considered to have been lost when a salmon was found to have the secondary mark (cut adipose fin), but no anchor tag. Details of weir and sonar operations are documented for the Tuluksak River by Zabkar et al. (2006), for the Aniak River by McEwen (2006), for the George River by Stewart et al. (2006), for the Kogrukluk River by Jasper and Molyneaux (*In prep*), for the Tatlawiksuk River by Costello et al. (*In prep* b), and the Takotna River by (Costello et al. *In prep* a).

[2] Product names used in this report are included for scientific completeness, but do not constitute a product endorsement.

Tagged fish were often caught or found by subsistence, commercial, or and sport fishers who were encouraged to return tags through a lottery reward system advertised in posters, radio announcements, and public meetings. Fishers willing to participate in the lottery could provide tag information by calling an Anchorage ADF&G regional office toll-free phone number, call or visit the ADF&G Bethel office, any Kuskokwim River tribal office, the Kuskokwim Native Association (KNA), or the Yukon Delta National Wildlife Refuge office. Recovery data were recorded on paper forms then entered into an Access database postseason. Tag numbers were matched to the 2005 data set, but if a tag number did not match the 2005 data set, it was checked against previous year's databases. In addition, Department and KNA staff conducted focused carcass tag recovery efforts on the Holokuk (rkm 362), Oskawalik (rkm 398), Cheeneetnuk (rkm 587), Gagarayah (rkm 634), Selatna (rkm 663), and Nunsatuk (rkm 620) rivers, as well as Telaquana Lake (rkm 756).

DATA ANALYSIS

Data Entry

Data on environmental conditions, fish tagged, fish recaptured, and shift information such as date, time, location, etc. were entered daily into a Juniper Systems Allegro CE data logger by crews as they tagged or recaptured salmon from fish wheels and drift gillnets. After each shift data from the data loggers were downloaded onto computers where they were imported into Microsoft Access tables in a temporary database. Tag recovery information from escapement projects and from volunteer recaptures was recorded on paper at designated reporting locations. Postseason all 2005 data were imported into a final Access database where recovery data collected from weirs or the public were entered manually. Data extracted from the database were analyzed for run timing, travel speed, and used to calculate coho salmon abundance.

Stock-specific Run Timing

The run timing of specific salmon spawning stocks passing Kalskag was estimated by comparing the release dates of tagged fish recovered at upriver weir sites or by voluntary recoveries in tributary stream. Tags recovered from a specific tributary or spawning aggregate were pooled and the collective run timing for that group was portrayed graphically along with other spawning aggregates by date tagged at Kalskag. Tributaries or areas of the drainage from which more than 4 tags were recovered by the public (volunteer recoveries) were added to this review. Voluntary recoveries were pooled within a drainage and the temporal distribution by date tagged was estimated; however, unlike at the tributary projects, the location of voluntary recoveries do not represent a specific point of passage in the tributary stream. For example, voluntary recoveries from the lower reaches of the Holitna were pooled with recoveries from the headwaters to estimate the mean run timing into the Holitna River. Volunteer tag recoveries were selectively chosen based on information provided that allowed us to place them with high confidence within certain Kuskokwim River tributaries.

Travel Speed

Travel speed (rkm/day) for each tagged salmon was calculated as the difference in rkm between the location of capture for tag deployment and location of tag recovery divided by the number days between time of release from the tagging site and the recovery event:

Travel speed = [distance (rkm) between tagging site and recaptured location]/[recaptured date - tagged date].

Abundance Estimate Diagnostics

For the estimate of coho salmon abundance from the mark–recapture experiment to be unbiased the following assumptions need to be fulfilled (Seber 1982):

1. Tagged fish did not lose their marks between sampling events.
2. Every fish had an equal probability of being tagged during the first sampling event, or every fish had an equal probability of being recaptured during the second sampling event, or marked fish mixed completely with unmarked fish between sampling events.

For the first assumption, tag loss was evaluated at upstream escapement projects by visual inspection for secondary marks on all salmon. This procedure was incorporated into the ASL protocol at upriver escapement projects where ASL sampled salmon were examined for secondary marks, as well as conducting additional sampling during the coho migration. Since 2005 yielded new tag types, we were unable to pool data from 2002–2004.

To meet the second assumption, salmon were tagged at the Kalskag site between June 1 and September 9, and were recaptured from June 10 to September 22 at weir sites, which provided enough time for tagged fish to reach the recapture site. Because tagging was conducted on multiple stocks, each stock should have had an equal chance of capture. To examine this, a chi-square test was conducted in which proportion of tagged fish was compared among the 4 recapture sites for each tagging gear types.

Abundance Estimate

Chapman's abundance estimator (Seber 1982) was used to estimate abundance:

$$\hat{N} = \frac{(C+1)(M+1)}{R+1} - 1 \qquad (1)$$

where:

$\hat{N}$ = estimated abundance of salmon in the Kuskokwim River upstream from the Lower Kalskag site,

M = the number of salmon tagged at the Kalskag site,

C = the number of salmon examined at upstream escapement projects, and

R = the number of tagged salmon recovered at upstream escapement projects.

Its variance and 95% Confidence Interval was estimated using a 1000 parametric Bootstrap simulation, which was based on a hypergeometric distribution.

RESULTS

TAG DEPLOYMENT

Tag deployment in 2005 occurred at 2 fish wheels and from drift gillnets from June 1 to September 9,one day longer than the targeted period of operation. Tag deployment on the right bank #2 fish wheel however occurred from June 2 to September 9 due to a delay in positioning the wheel. The right bank #1 fish wheel was successfully deployed at the location used

previously from 2001 to 2003 upstream of the village of Kalskag. The left bank fish wheel was successfully deployed at a new location further upstream, as was the right bank #2 fish wheel. Three drift gillnetting sites were selected to correlate with the locations of the fish wheels to sample fish offshore from the fish wheels (Figure 3). The majority of tag deployment from gillnets took place using 10-fathom nets (98.5%). Because of manageable catch rates, 5-fathom nets (1.5%) were rarely needed.

Chinook Salmon

A total 1,211 Chinook salmon were caught of which 1,198 (98.9%) were subsequently tagged (Table 2; Figure 4; Appendix A1). Combined catches in fish wheels and gillnets remained under 10 fish per day from June 1 to June 6, peak catches occurred from June 15 to June 27, then catches decreased to less than 10 Chinook salmon per day after July 13 (Figure 5). The left bank fish wheel accounted for 507 of the catch with 503 fish tagged, the 2 right bank fish wheels accounted for 357 of the catch with 349 fish tagged, and gillnets accounted for 347 of the catch with 346 fish tagged.

Sockeye Salmon

A total 4,881 sockeye salmon were caught of which 4,648 (95.2%) were subsequently tagged (Table 2; Figure 6; Appendix A2). Combined catches in fish wheels and gillnets remained under 10 fish per day from June 1 to June 16, peak catches occurred from July 2 to July 11, then catches decreased to less than 10 sockeye salmon per day after August 29 (Figure 7). The left bank fish wheel accounted for 1,258 of the catch with 1,243 fish tagged, the 2 right bank fish wheels accounted for 3,499 of the catch with 3,285 fish tagged, and gillnets accounted for 124 of the catch with 120 fish tagged.

Chum Salmon

A total 30,534 chum salmon were caught of which 28,416 (93.1%) were subsequently tagged (Table 2; Figure 8; Appendix A3). Combined catches in fish wheels and gillnets remained under 10 fish per day from June 1 to June 16, peak catches occurred from July 5 to July 28, and catches remained above 10 chum salmon per day until the wheels were shut off the last day of operation (Figure 9). The left bank fish wheel accounted for 6,476 of the catch with 6,303 fish tagged, the 2 right bank fish wheels accounted for 23,557 of the catch with 21,645 fish tagged, and gillnets accounted for 501 of the catch with 468 fish tagged.

Coho Salmon

A total 5,723 coho salmon were caught of which 5,512 (96.3%) were subsequently tagged (Table 2; Figure 10; Appendix A4). Combined catches in fish wheels and gillnets remained under 10 fish per day from June 1 to July 19, peak catches occurred from August 12 to August 31, and catches remained above 100 coho salmon per day until the wheels were shut off the last day of operation (Figure 11). The left bank fish wheel accounted for 1,216 of the catch with 1,198 fish tagged, the 2 right bank fish wheels accounted for 4,130 of the catch with 3,944 fish tagged, and gillnets accounted for 377 of the catch with 370 fish tagged.

TAG RECOVERY

Tags were recovered throughout the Kuskokwim River drainage, including tributary escapement projects, dedicated carcass surveys at selected streams, and opportunistic voluntary recoveries. This last category included some recoveries from clearly identified tributary streams, but more

often the recoveries were from subsistence and commercial catches in the mainstem Kuskokwim River. Tag recovery at upstream escapement projects occurred from June 23 to September 24 at the Aniak River sonar site, June 15 to September 20 at the George River weir, June 12 to September 22 at the Tatlawiksuk River weir, June 22 to September 22 at the Kogrukluk River weir, and from June 10 to September 20 at the Takotna River weir. Tag recovery conducted using dedicated carcass surveys occurred on August 5 (Nunsatuk), August 8 and 22 (Oskawalik), August 12 (Gagaryah), August 14 (Selatna), and September 1 (Holokuk).

Chinook Salmon

A total of 139 anchor tags were observed or recovered on Chinook salmon at tributary escapement projects, of which 129 (92.8%)were recovered (Table 3). Three tags were observed at Tuluksak River weir, which is located downstream of the tagging sites, and 136 tags were observed from escapement projects upstream of the tagging site (Appendices B1–B5). The dedicated carcass surveys conducted in selected tributary streams did not yield any anchor-tagged Chinook salmon; however, 36 tags were returned through opportunistic voluntary tag recoveries from subsistence, commercial, and sport fishers (Table 4; Appendix C1).

Sockeye Salmon

A total of 282 anchor tags were observed or recovered on sockeye salmon at tributary escapement projects, of which 254 (90.1%) were recovered (Table 3). There were 30 tags observed or recovered at Tuluksak River weir, which is located downstream of the tagging sites, and 252 tags were observed or recovered from escapement projects upstream of the tagging site (Appendices B1–B5). Dedicated carcass surveys conducted in selected tributary streams only yielded 4 anchor-tagged sockeye salmon all from Telaquana Lake near the outlet of the lake; however, 84 tags were returned through opportunistic voluntary tag recoveries from subsistence, commercial, and sport fishers (Table 4; Appendix C2).

Chum Salmon

A total of 720 anchor tags were observed or recovered on chum salmon at tributary escapement projects, of which 650 (90.3%) were recovered (Table 3). There were 45 tags observed or recovered at the Tuluksak River weir, which is located downstream of the tagging sites, and 675 tags were observed or recovered from escapement projects upstream of the tagging site (Appendices B1–B5). The dedicated carcass surveys conducted in selected tributary streams yielded 22 anchor-tagged chum salmon all from the Oskawalik River; however, 245 tags were returned through opportunistic voluntary tag recoveries from subsistence, commercial, and sport fishers (Table 4; Appendix C3).

Coho Salmon

A total of 343 anchor tags were observed or recovered on coho salmon at tributary escapement projects, of which 324 (94.5%) were recovered (Table 3). There were 5 tags observed or recovered at the Tuluksak River weir, which is located downstream of the tagging sites, and 338 tags were observed or recovered from escapement projects upstream of the tagging site (Appendices B1–B5). The dedicated carcass surveys conducted in selected tributary streams did not yield any anchor-tagged coho salmon; however, 184 tags were returned through opportunistic voluntary tag recoveries from subsistence, commercial, and sport fishers (Table 4; Appendix C4).

STOCK-SPECIFIC RUN TIMING

Chinook Salmon

The timing of specific Chinook salmon stocks passing upstream of the Kalskag tagging site was determined through the use of tags recovered at Takotna, Kogrukluk, Tatlawiksuk, and George River weirs (Table 5; Figures 12 and 13). The median tagging dates for recovered tags from each of these 4 stocks were June 14, 20, 20, and 22, respectively.

Sockeye Salmon

The timing of specific sockeye salmon stocks passing upstream of the Kalskag tagging site was determined through the use of tags recovered at Takotna, Kogrukluk, Tatlawiksuk, and George River weirs, as well as tags recovered from dedicated carcass surveys at Telaquana Lake (Table 5; Figure 14). The median tagging dates for recovered tags from each of these 5 stocks were August 15, July 4, July 19, August 9, and July 2, respectively.

Chum Salmon

The timing of specific chum salmon stocks passing upstream of the Kalskag tagging site was determined through the use of tags recovered at Takotna, Kogrukluk, Tatlawiksuk, and George River weirs, and from Aniak River beach seining (Table 5; Figure 15), as well as tags recovered from carcass surveys conducted at Oskawalik River. The median tagging datse for recovered tags from each of these 6 stocks were July 3, 5, 7, 20, 27, and 28, respectively.

Coho Salmon

The timing of specific coho salmon stocks passing upstream of the Kalskag tagging site was determined through the use of tags recovered at Takotna, Kogrukluk, Tatlawiksuk, and George River weirs, as well as tags recovered from volunteer fishers at Aniak River(Table 5; Figure 16). The median tagging dates for recovered tags from each of these 5 stocks weres August 6, 16, 17, 29, and 9, respectively.

STOCK-SPECIFC TRAVEL SPEED

A description of travel speed and travel time for specific salmon stocks passing upstream of the Kalskag tagging site was determined through the use of tags recovered at Takotna, Kogrukluk, Tatlawiksuk, and George River weirs, as well as recovery of tags from chum salmon caught in beach seining in the Aniak River.

Chinook Salmon

Tag recoveries of Chinook salmon from upstream escapement projects did not show an increase in travel speed with an increase in distance from the tag site, but instead showed similar travel speeds (Table 6; Figure 17). The mean travel speed of fish recovered at the Takotna River weir was 22 rkm/day (n=3, SD=7.3), the Kogrukluk River weir 22 rkm/day (n=99, SD=7.5), the Tatlawiksuk River weir 20 rkm/day (n=16, SD=9.8), and the George River weir 21 rkm/day (n=11, SD=6.0).

Sockeye Salmon

Tag recoveries of sockeye salmon from upstream escapement projects did not show an increase in travel speed with an increase in distance from the tag site except for Takotna (Table 6; Figure 18). The mean travel speed of fish recovered at the Takotna River weir was 40 rkm/day

(n=2, SD=9.8), the Kogrukluk River weir 26 rkm/day (n=214, SD=7.8), the Tatlawiksuk River weir 25 rkm/day (n=3, SD=4.2), and the George River weir 24 rkm/day (n=15, SD=8.7).

Chum Salmon

Tag recoveries of chum salmon from upstream escapement projects did show an increase in travel speed with an increase in distance from the tag site, but differences were small (Table 6; Figure 19). The mean travel speed of fish recovered at the Takotna River weir was 39 rkm/day (n=6, SD=3.5), the Kogrukluk River weir 34 rkm/day (n=176, SD=5.6), the Tatlawiksuk River weir 36 rkm/day (n=160, SD=5.8), the George River weir 33 rkm/day (n=262, SD=12.0), and the Aniak River sonar 19 rkm/day (n=20, SD=5.4).

Coho Salmon

Tag recoveries of coho salmon from upstream escapement projects showed an increase in travel speed with an increase in distance from the tag site (Table 6; Figure 20). The mean travel speed of fish recovered at the Takotna River weir was 26 rkm/day (n=14; SD=6.4), the Kogrukluk River weir 24 rkm/day (n=200, SD=6.5), the Tatlawiksuk River weir 23 rkm/day (n=31, SD=6.9), and the George River weir 20 rkm/day (n=77, SD=7.7).

ABUNDANCE ESTIMATE DIAGNOSTICS

In 2005, no tag loss was observed in 4,837 coho salmon inspected for secondary marks at the George River weir (n=1,329), Kogrukluk River weir (n=1,040), Tatlawiksuk River weir (n=1,409) and Takotna River weir (n=1,059). However, tag loss was observed in1 of the 2,113 Chinook salmon inspected at all weirs and in 2 of 7,446 chum salmon inspected at all weirs (Table 8). We considered our first assumption of no tag loss to be satisfied in that no coho salmon examined at weirs were found to have lost their tags. Studies have found that the use of anchor tags on species such as Arctic grayling *Thymallus acticus* and Gulf sturgeon *Acipenser oxyrinchus desotoi* produced low initial rates of tag loss (Buzby and Deegan 1999; Clugston 1996). McPherson et al. (1996) observed a 5% tag loss in coho salmon tagged with anchor tags and recovered in Steep Creek.

Testing of our second assumption of mixing led us to pool coho salmon marked at the 2 right bank fish wheels with salmon tagged from drift gillnets because of the similar tag recovery ratios at the 4 upstream weirs (chi-square=6.323, df=3, P= 0.0969). Of note was the highly significant difference among tag recovery ratios of coho salmon tagged from the left bank fish wheel (chi-square=15.570, df=3, P=0.001389). Tag ratios for the 2 right bank fish wheels (chi-square=6.592, df=3, p=0.0861) and for drift gillnetting (chi-square=0.155, df=3, P=0.985) did not differ significantly. As a result, recaptures of coho salmon tagged from drift gillnets and the 2 right bank fish wheels were combined, and mark and recaptures from left bank fish wheel were discarded for abundance estimation (Table 9).

COHO SALMON ABUNDANCE ESTIMATE

An estimate of the total coho salmon abundance upstream of the Kalskag site was 640,736 using the Chapman estimator (95% CI 547,011, 746,953; SE=52,541; Table 7). The estimate was calculated using data from tag deployment at the Kalskag right bank fish wheel and gillnets with recovery data from upstream tributary escapement projects. Downstream recoveries were censured from the analysis. The negative bias of the downstream migrants is low and falls within

the bounds of the estimates confidence interval. The effect of tag loss was considered insignificant, and not incorporated into the analysis.

DISCUSSION

TAG DEPLOYMENT AND RECOVERY

In 2005, the design of the Kuskokwim River mark–recapture project changed from the previous year of operation. Due to the poor locations of the fish wheels in 2004, we moved back to the Kalskag capture site where the project had originally started and operated from 2001 through 2003. The Aniak recapture site was not operated this year as well. Instead, we used the upriver escapement projects as our recapture event for the purpose of estimating stock-specific run-timing, stock-specific travel speed, and coho salmon run abundance. Also different was the addition of a third fish wheel located on the right bank to increase the number of tagged salmon released. This was possible due to the fact that we changed tag types from using Floy® spaghetti tags to using Floy® T-bar anchor tags, allowing us to tag salmon at a much faster rate.

The operation of the fish wheels in 2005 was more successful than in 2004. Initial locations of the 3 fish wheels were used throughout the season with only minor adjustments. All 3 fish wheel locations had ample water velocity to maintain suitable rpm's and good river bottom contour to allow effective operation and movement during fluctuating water levels. Three locations near each of the fish wheels were used to deploy drift gillnets. These locations proved to be ideal as catch rates were good and nets were not lost or damaged beyond repair during the course of the season.

Fishing effort was very consistent for the fish wheels over the course of the season. Fish wheels were operated 24 hours a day with the exception of short periods of adjustment. The only fish wheel that had to be shut down for major repairs was the right bank #1 fish wheel on June 7 for a total of 24 hours. Catch rates at this time were low and the effect believed to be minimal on tag deployment. Fishing effort was not consistent; however, using drift gillnets (Figure 21). The amount of effort per day ranged from 18 to 170 minutes, with an average over the season of 97 minutes. Effort was higher at the beginning and end of the season when catch rates on the fish wheels were low.

Catches of Chinook, sockeye, chum, and coho salmon at the Kalskag capture site were among the highest levels ever observed. The relationship of catches at the Kalskag capture site and tributary monitoring projects varied among salmon species. A database kept since 2002 of all species caught at the capture site allowed us to compare Chinook salmon catches with 2005 since they were an addition to our target species. Using just the fish wheel catches, the total catch of Chinook salmon in 2005 even with the additional fish wheel was similar to years prior, with the tributary escapement projects showing stable escapements over that period of time with the exception of Kogrukluk River which increased in 2004 and 2005 (Table 10). The total catch of sockeye salmon is the largest in the 4 years this project has operated, and mirrors the escapement seen at the Kogrukluk River, the only weir operated this season that had significant sockeye abundance (Table 10). The total catch of chum salmon is also the largest in the 4 years this project has operated, and again mirrors what was seen at most of the escapement projects in the Kuskokwim River drainage (Table 10). Lastly, the catch of coho salmon was greater than that of

2004. However, drainage wide escapements indicate that coho salmon numbers were lower in 2005 than 2004 for all monitored tributaries (Table 10).

The new tagging method employed in 2005 helped us keep pace with the increased catch of the fish wheels. Floy® T-bar anchor tags were applied to salmon with lever release tag guns and were more efficient in marking salmon. The sampling time required for applying anchor tags was figured to be reduced by less than half the time required to apply spaghetti tags used in previous years.

Tagging effort was not consistent on the fish wheels over the course of the season. From July 28 to August 4, supplies of pink anchor tags used to tag salmon from the right bank fish wheels ran out, and we were forced to use individually numbered blue spaghetti tags leftover from previous years. During this period only every other sockeye and chum salmon were tagged to allow crews to keep up with high catches. However, every Chinook and coho salmon was marked with a spaghetti tag during this period to increase sample sizes of each for stock-specific run-timing and run abundance estimates, respectively. The only salmon that weren't tagged throughout the remainder of the season on fish wheels were either unhealthy, escaped, or were releasing gametes. As a result of this period, sockeye and chum salmon tagged with a blue spaghetti tag were weighted as 2 fish for stock-specific run-timing analysis. Tagging effort was consistent for salmon caught in drift gillnets, as no tag shortages occurred and only salmon that were unhealthy, escaped, or were releasing gametes were not tagged.

Tag recovery locations proved to be successful for recovery of sufficient numbers of Chinook, chum, and coho salmon. However, only the Kogrukluk weir had sufficient numbers of sockeye salmon. The locations where tag recoveries occurred are beneficial in that they were spread throughout the drainage and should help provide information on different geographic areas of the Kuskokwim.

Tag recovery was performed at Takotna, Telaquana, Kogrukluk, Nunsatuk, Gagaryah, Selatna, Tatlawiksuk, George, Oskawalik, Holokuk, and Aniak rivers in 2005 using a variety of methods including weirs, beach seining, and carcass surveys. Weirs employed at Takotna, Kogrukluk, Tatlawiksuk and George river's were more effective in recovering significant quantities of tags as they operate during the majority of Chinook, sockeye, chum, and coho salmon passage, and force fish to pass through a narrow gate, enabling marked fish to be seen and recovered. Beach seining was performed on the Aniak River and was successful in capturing salmon. Drawbacks to using beach seines, however, include time needed to deploy and retrieve the seine, the need for at least three crew members to use them, and the low catches compared to the weirs. Carcass surveys were done on the Telaquana, Nunsatuk, Gagaryah, Selatna, Oskawalik, and Holokuk rivers, as well as Telaquana Lake with varying success. Tags were successfully recovered at Oskawalik and Telaquana, but were not recovered at the Nunsatuk, Gagaryah, Selatna, and Holokuk rivers. The failure to recover tags at the Nunsatuk, Gagaryah, and Selatna rivers was due to difficulty in navigating those streams to get to areas where spawning was occurring. The failure to recover tags at the Holokuk was due in large part to the fact that the survey was conducted in early September and most chum salmon had spawned and their carcasses were either devoured or had been flushed out of the system due to higher water levels. Throughout the season tags were recovered by volunteers and reported. Most of the recoveries were from subsistence fishers on the mainstem Kuskokwim.

Tag recovery effort varied with each method used. Weirs had a more consistent effort as they monitored fish passage on a daily basis throughout most of the salmon migration. Recovery effort of beach seining, however, was inconsistent with varying days of operation and number of hauls per day. Recovery effort of carcass surveys was focused on a single day and was limited to how far upstream the surveyors could travel and how much shoreline they could survey.

Tag recovery at weirs, in 2005, of salmon tagged at the Kalskag capture site were higher than any other year of operation except for coho salmon, which resulted in the second highest total, and the resulting stock-specific bank orientation was similar to previous years. Since this was the first year of tagging Chinook salmon with anchor tags, there was no previous tag recovery data at upstream escapement projects except for radio tags deployed by Stuby (2005). In combining both-anchor and radio-tagged Chinook salmon this year, all upstream escapement projects recovered 13 or more except for Takotna River which only recovered 3 (Table 11). Only 2 upstream escapement projects recovered more than 3 tagged sockeye salmon, George River with 17 and Kogrukluk River with 214 (Table 11). Chum salmon tag recovery was very successful with each upstream escapement project recovering the most tags from the Kalskag/Lower Kalskag capture sites ever (Table 11). All 4 upstream weir projects recovered over 13 tagged coho salmon (Table 11).

Bank orientation of migrating Chinook, sockeye, chum, and coho salmon marked at the tagging site was determined by comparing tag recoveries at upstream escapement projects to tag output at the tagging site. In 2005, the majority of tagged Chinook salmon were from the left bank fish wheel and from gillnets (42%, n=503; 29%, n=346). The only upstream escapement project with substantial tag recovery of Chinook salmon was the Kogrukluk River weir, which had a higher proportion of drift gillnet tag recoveries (40%, n=40) and a lower proportion of right bank fish wheel tag recoveries (15%, n=15) compared to the tagged proportions at Kalskag, suggesting a more mid-channel orientation (Table 11; Figure 22). In contrast, the majority of sockeye salmon were tagged from the right bank fish wheels and subsequently the majority of tag recoveries at Kogrukluk River weir, the only monitored tributary with a significant run, were similar to the proportional tag output by gear location (Table 11; Figure 23). The majority of chum salmon were also tagged from right bank fish wheels, but when compared to tag recoveries from upstream monitoring projects they demonstrate varied differences in proportions by gear location (Table 11; Figure 24). The Aniak River tag recoveries show a very high proportion of left bank tagged salmon suggesting strong left bank orientation. In contrast, the majority of chum salmon tag recoveries at Kogrukluk River weir were from the right bank fish wheels at a disproportionate amount compared to the tag output, suggesting right bank orientation. Coho salmon displayed very similar tag proportions from both tag output and tag recoveries from all the upstream monitoring projects suggesting no or very little bank orientation exists (Table 11; Figure 25).

RUN TIMING

Several assumptions are implicit in our use of recovered tags to describe migratory timing at the Kalskag tagging site and furthermore the usefulness of that knowledge to fishery managers downriver. Assumptions are that tagged fish are representative of untagged fish, i.e. that tagging occurred proportionally throughout the run and that recovery effort is also consistent. If a chronology of timing exists at Kalskag we assume (Killick 1955) it is maintained during the earlier inriver migration for it to be of use to fishery management downriver.

There is the additional assumption that location and date of recovery are reported accurately for voluntary recoveries. Inclusion of these data was an effort to utilize the many volunteer tag recoveries and to test our existing assertion that stocks traveling further upstream are passing Kalskag earlier than stocks traveling to less distant tributaries. A source of bias associated with using volunteer tag recoveries includes inconsistent recovery effort over time that could bias the estimated run timing by shifting it earlier or later. Also, in our analysis of tag recoveries from escapement projects, we know where tags are recovered to the mile for that tributary. However, when using volunteer tag recoveries we have mixed information as to the specific location along a certain tributary, and sometimes have recoveries from different areas of a tributary and therefore cannot really assign a distance traveled to use in the run timing comparisons.

During the shortage of pink anchor tags, blue spaghetti tags were used to tag all 4 target species. During this period every Chinook and coho salmon were tagged. In contrast, only every other sockeye and chum salmon was tagged. For run timing analysis, every sockeye and chum salmon recovered with a blue spaghetti tag was weighted as counting for 2 fish.

Differences between the dates of median salmon passage at a weir project (untagged fish) and median date of tagged salmon at a weir project may be due to sulking or biased tag deployment (Jones III et al. 2001; Bernard et al. 1999). In 2003, when tag deployment levels were good, median dates of recovered tagged fish were later than the median date for total passage at weirs and differed by 3 days for sockeye and1 or less days for chum salmon and 3 days for Kogrukluk and Takotna River coho salmon. This delay was attributed to sulking which does not affect Kalskag run timing. The same was observed in 2005 for sockeye and coho salmon median dates for recovered tagged fish, with sockeye differing by 6 days and coho by 5 to 7 days (Table 5). Chum salmon median dates varied however with Tatlawiksuk River median passage matching that of the tag recovery passage, and the Kogrukluk River tag recovery median passage actually preceding that of the weir passage by 2 days (Table 5). Chinook salmon however exhibited little if any differences (Table 5). The varying discrepancies in 2005 for chum salmon are possibly due to problems of tagging stocks in proportion to abundance due to the large numbers of chum salmon migrating up the Kuskokwim River, or problems of recovering tags at the escapement projects, specifically Kogrukluk River which experienced the highest passage of sockeye and chum salmon ever on record (Jasper and Molyneaux, *In prep*).

Since such a large number of salmon were tagged and recovered in 2005, and no problems occurred throughout the season in deploying tags, we feel these data are adequate in describing run timing and travel speed. However, discrepancy should be used for stocks displaying large differences in median dates between tagged and untagged salmon as not being representative. Overall, tagged fish were judged representative of untagged fish for estimating stock-specific run timing at Kalskag. We have placed 2005 data alongside data collected in earlier years to see if patterns are strong enough to be identified across years.

Chinook salmon tagged with anchor tags were pooled with Chinook salmon tagged with radio tags to increase sample size for analyzing run timing of specific stocks. Stock-specific run timing results for Chinook salmon in 2005 indicate that earlier tagged fish traveled further upstream than fish tagged later in the season (Table 5). Takotna River recoveries pass Kalskag earlier than Kogrukluk and Tatlawiksuk, followed by George River recoveries, although median tag dates are not separated by much (Figure 12). This general pattern has been observed by Stuby (*In prep*) from 2002 to 2005, during which a radio-tagging study has been conducted alongside the Kuskokwim River tagging project (Figure 13).

Of the 4 upstream weirs, only the Kogrukluk River has a sizable sockeye salmon run (>4,000 fish per year). Even so, we have recovered a few sockeye salmon tags at the other escapement projects, from 2002 to 2005, and when we compare the distribution of dates tagged, a pattern of stock-specific run timing becomes evident regardless of run size (Figure 14). Sockeye salmon tagged earlier in the year traveled farther those tagged later in the year, except for the Takotna River tag recoveries. However, being as Takotna River never sees more than 100 sockeye salmon pass the weir, the fact that tags have been recovered there could be associated with tagging stress. This pattern of timing was similar to what Merritt and Roberson (1986) found on upper Copper River sockeye salmon stocks. However, more effort is needed to recover tagged sockeye salmon at tributaries of high abundance to better compare stock-specific run timing patterns.

A pattern of stock-specific run timing for chum salmon at Kalskag was also consistent for 2002 through 2005 (Figure 15), where, again, earlier tagged fish traveled further upstream than fish tagged later in the season (Kerkvliet et al. 2003; Kerkvliet et al. 2004; Pawluk et al. *In prep*). Two clusters of timings appear to represent the farthest migrating stocks (Takotna, Stony, Kogrukluk and Tatlawiksuk) versus chum salmon from tributaries closer to the tagging site (George, Oskawalik, Holokuk, and Aniak). Anomalous are the 17 voluntary tag recoveries from the Holitna River with quite late run timing.

In previous years, a discrepancy existed between run timing estimates at Kalskag/Lower Kalskag of chum salmon tags recovered at the Aniak sonar site versus the tags recovered voluntarily (Figure 15). This difference might have been due to two factors. The first being that the Aniak River sonar only operates for the month of July, therefore skewing Kalskag/Lower Kalskag run timing from tag recovery data early as chum salmon still enter the Aniak River throughout August. Also, the recovery method of using a beach seine is less intensive and done only a few times a week, causing low and sporadic tag recoveries (McEwen *In prep*). The curve representing volunteer tag recoveries in the Aniak River would best represent the chum salmon run timing from 2002 to 2004, as these tags were recovered throughout the summer and into the fall when water levels drop. In 2005, however, additional sampling was pursued on the Aniak River using beach seines by both the sonar crew and members of our cooperative partner, KNA. Sampling was extended past the stop date of the Aniak sonar (July 31) to Sept. 24. An attempt was made to mimic the sampling schedule performed by the sonar crew throughout this time. This resulted in a later median tag date ever observed for the Aniak River escapement project and also displaced the Aniak volunteer recovery median date as being the latest (Figure 15).

Data from both voluntary recoveries and weir projects were used to estimate stock-specific run timing for coho salmon since 2002. In 2005, there seemed to be clear resolution in run timing between stocks monitored by weirs in order of distance traveled; however there were few volunteer tags analyzed (Figure 16). For example, the Takotna River tag recoveries had a median tag date earlier than the Kogrukluk River, which was earlier than the Tatlawiksuk River, and all earlier than the George River. Chronological differences in run timing by distance traveled were not as apparent for coho salmon from 2002 to 2004 (Figure 16) as for the other salmon species. Based on weir project recoveries Kerkvliet et al. (2003 and 2004) noted that earlier tagged coho salmon traveled further upstream than fish tagged later in the season. However, the median tag date of the Aniak River and Holitna River volunteer tag recoveries is much earlier than would be expected in relation to the distance from the tagging sites, a likely result of effort by volunteers taking place earlier in the season. In the opposite direction, tags recovered from the Kuskokwim

River above the mouth of the Takotna River (17 in 2003, 9 in 2002) had a median tag date much later than any other tributary analyzed. It is unlikely that this is due to tag recovery effort as most subsistence and sport fishing along the Kuskokwim River is done earlier in the year to take advantage of more favorable weather.

Several project operation features and the biology of coho salmon could help explain the lack of chronological run timing. Coho salmon have extended run timing and the project does not necessarily operate through the end of the run. Tag recovery at weirs ended at the same time through out the drainage even though they are different distances from the tagging site. Volunteer tag recover effort is also weighted towards the early part of salmon runs with more fishing effort directed toward Chinook than coho salmon, thus more likely to recover Chinook, sockeye, chum, or early run coho salmon tags than later running coho salmon.

TRAVEL SPEED AND TRAVEL DAYS

Travel speeds were calculated from the Kalskag tagging site to upriver escapement projects for the purpose of stock comparison. Travel speed does not presume salmon actually travel this speed. It assumes a point-to-point path to the recovery location and no response to handling, and downstream or meandering movements. Again, when comparing between recovery locations any non-point to point travel is assumed constant among stocks.

Tag recovery data from escapement projects allowed us to assess travel speed of monitored stocks. To fully understand these types of data, one needs to be aware of potential biases when the behavior of tagged fish is not the same as untagged fish. There is ample literature indicating that initially after tagging, fish "sulk" (Bernard et al. 1999; Jones III et al. 2001). When sulking behavior is considered in estimating travel speed, the travel time of tagged fish would likely be slower than untagged fish.

Being this was the first year Chinook salmon were tagged with anchor tags there is no previous data to compare travel speeds. Chinook salmon with anchor tags were pooled with Chinook salmon with radio tags to boost sample sizes. Travel speed was found to be similar for Chinook salmon recovered at all 4 upstream weirs with George River having a mean speed of 21 (rkm/day), Tatlawiksuk River a mean speed of 20 (rkm/day), Kogrukluk River a mean speed of 22 (rkm/day) and Takotna River a mean speed of 22 (rkm/day) as well (Table 6). When displayed graphically, these data show an increase in travel speed as the season progresses, similar to what's seen with coho salmon in this study (Figure 17).

Sockeye salmon tag recoveries of ample sizes have only occurred at the Kogrukluk River weir during the past 4 seasons. Travel speed was similar from 2002 to 2005 for sockeye salmon to the Kogrukluk River weir ranging from 23 to 26 (rkm/day) (Table 6; Figure 18).

Large sample sizes of tag recoveries of chum salmon from weirs have occurred throughout the duration of this project (2002–2005) for all escapement projects except during 2004. During this period, travel speed for chum salmon at the Aniak River sonar site has ranged from 17–19 (rkm/day), the George River weir from 27–33 (rkm/day), the Tatlawiksuk River weir from 28–36 (rkm/day), the Kogrukluk River weir from 31–34 (rkm/day), and the Takotna River weir from 35–39 (rkm/day). Results from 2005 continue to suggest that chum salmon traveling further upstream travel faster than those traveling less distance (Table 6; Figure 19).

Coho salmon tag recoveries have also maintained high levels throughout 2002–2005. During this period, travel speed for coho salmon at the George River weir has ranged from 13–21 (rkm/day),

the Tatlawiksuk River weir from 18–23 (rkm/day), the Kogrukluk River weir from 23–26 (rkm/day), and the Takotna River weir from 26–31 (rkm/day). Results from 2005 continue to suggest that coho salmon traveling further upstream travel faster than those traveling less distance (Table 6; Figure 20).

Comparisons of travel speed between early and late season coho salmon among years (2001–2005) was not possible. Difficulties occur when travel speeds are grouped as early run or late run fish, which do not provide the clear resolution between the two groups across all years. However, graphically displayed data and statistical analysis by year shows a difference between early and late run coho salmon, where the travel speed of later returning coho salmon increased (Figure 20). Differences in travel speed between early and late may be attributed to milling behavior similar to the findings of McPherson et al. (1996). Results from this study have shown that coho salmon that enter the stream early in the season exhibit milling behavior longer at the marking site than those that enter the stream later in the season.

COHO SALMON ABUNDANCE ESTIMATE

This was the fifth year of estimating coho salmon abundance in the Kuskokwim River upstream of Kalskag/Lower Kalskag. This was the first year, however, that tags were not recaptured by gill nets and fish wheels at the Aniak recovery site. The abundance of coho salmon in 2005 was estimated from marking at the Kalskag site and recapturing at upstream tributary escapement projects (referred to as a wheel-to-weir estimate). Using the Chapman estimator and bootstrapping to 1000 simulations, an abundance estimate of 640,736 (95% CI 547,011, 746,953; SE=52,541) coho salmon was calculated. In 2002 through 2004, coho salmon abundance was estimated used a different data set: tagging at Lower Kalskag or Kalskag and recapturing with gillnets and fish wheels at the Aniak recovery site (referred to as a wheel-to-wheel estimate). Furthermore, from 2002 through 2004 data were stratified through time and a Darroch estimator was used.

To compare abundance among years and with tributary escapement data, we estimated coho salmon abundance from 2001 to 2004, using data from coho salmon tagged at the Kalskag/Lower Kalskag sites and recaptured at upriver tributary escapement projects (wheel-to-weir estimates). Data were not stratified and the Chapman estimator was used. In addition, we used the published estimates from 2002 to 2004 based on coho salmon tagged at the Kalskag/Lower Kalskag sites and recaptured at the Aniak site (wheel-to-wheel estimates) in which the Darroch estimator was used (Kerkvliet et al. 2003; 2004; Pawluk et al. *In prep*). This resulted in a time series of wheel-to-weir abundance estimates from 2001 to 2004 and wheel-to-wheel abundance estimates in 2002 through 2004 (Table 7) which could be compared to tributary escapement weir counts (Figure 26).

Each data set used to estimate coho abundance in the Kuskokwim River above Kalskag or Lower Kalskag has flaws. Stock-specific bank orientation is evidenced in some years as Aniak River coho salmon tend to be caught along the left bank of the Kuskokwim River at Kalskag and other upriver stocks caught in higher proportion along the right bank and offshore gillnetting. Our fish wheel recovery site is just downstream of the Aniak River. Furthermore the project lacks tag recovery efforts in the Aniak River comparable to what occurs at upstream weirs. The wheel-to-wheel estimates could underestimate abundance when there isn't sufficient mixing between banks. If we disproportionately tag Aniak River coho salmon at a rate higher than other stocks we would underestimate abundance with the wheel-to-wheel estimate. The wheel-to-weir data set may overestimate or underestimate abundance when not all stocks are tagged equally. Over estimation would occur if Aniak coho salmon are tagged at a higher rate and then are not part of the tributary

recovery program. Tag recovery ratios at the other weirs are biased low because you overestimate number of tags deployed that could be recovered at the weirs. The direction of bias would reverse if upstream stocks were tagged at a higher rate. In conclusion, either data set/method can produce bias and it is important to know the possible source of bias and the direction of the bias. Thus it is important to place our estimates in context of other escapement projects and harvest levels.

Estimates of coho salmon using wheel-to-weir data were similar in 2001 and 2002, increased dramatically in 2003 to 2004 and declined in 2005 (Figure 27). Estimates of abundance based on wheel-to-wheel data were similar to their wheel-to-weir counterpart for 2002 and 2003 but were quite different in 2004. We do not know why the 2004 wheel-to-weir estimate was so much higher than the wheel-to-wheel estimate. In 2004 tag recovery ratios observed at the upstream tributary weirs were statistically similar and other assumptions were fulfilled as in other years. Three things however were different, one being that the marking event took place not only in a new location, 21 rkm downstream from the Kalskag site, but also in a section of the Kuskokwim River with a single channel to include missed coho salmon traveling up the "Old River" channel to the south. Second, even though almost 3,000 coho salmon were tagged, only 112 tags were recaptured at the 4 upstream tributaries, the lowest number during this study. Finally, water levels were at record lows in 2004 and caused problems in keeping the fish wheels operational (Figure 28). The right bank fish wheel revolutions per minute dwindled and it had to be shut down the final 6 days, leaving the left bank fish wheel the only one operating. Based on these three facts, it is very possible a disproportionate number of Aniak River coho salmon were marked causing abundance to be overestimated in 2004, as results from previous tag recoveries on the Aniak River have shown the majority are tagged from the left bank fish wheel. These problems would not occur for the estimate using the wheel-to-wheel data set as the Aniak site is located downstream of the Aniak River, and coho salmon bound for the Aniak River would not have a chance to leave the system before recapture. We do not believe the wheel-to-weir population estimate in 2004 is accurate.

Tributary monitoring projects share a similar trend in abundance with the mainstem population estimates and furthermore support our decision not to use the wheel-to-weir estimate of 2004. Generally, tributary escapements were lower in 2001 and 2002, record high in 2003 and dropping again in 2004. Tributary escapements in 2005 also appear generally lower than 2004 and similar to 2001 and 2002. In contrast only the wheel-to-weir abundance estimate of 2004 was greater than the 2003 value and the 2005 estimate was significantly higher that the 2004 wheel-to-wheel estimate (i.e. above the 95% CI). When weir counts are normalized against their 2001–2005 median value and viewed against mainstem abundance estimates (Figure 29), there is a strong correlation (with the omission of the 2004 wheel-to-weir estimate).

Our estimates of abundance are much greater than the sum of upstream tributary escapement estimates. The proportion of these abundance estimates represented in upstream tributary weirs ranges from 6% to 16%. Additional estimates exist for 2001 and 2002 (Stroka et al. 2004) for coho salmon in the Holitna River (63,442 and 157,277). When added to upstream weir counts, the sum represents 21% and 42% of the wheel-to-weir estimates of abundance. When all upstream coho salmon counts and estimates are added, the sum is still below the abundance estimates, leaving a substantial number of coho salmon which migrate to and spawn at unmonitored locations.

Abundance estimates from this project can be added to downstream tributary escapements and harvest data for estimates of total run from 2001 through 2005. These estimates have become part of our review of escapement goals for the 2007 Board of Fisheries meeting (Molyneaux et al. *In prep*). We estimate the total run of coho salmon to have ranged from 603,719 (2002) to 1,510,603

(2003) with total annual exploitation from 20% to 47% (Appendix D). Generally we chose to use the estimates of abundance upstream of Kalskag based on the wheel-to-weir data sets.

CONCLUSIONS

Tag Deployment and Recovery: The period of tag deployment encompassed the Chinook, sockeye, and chum salmon run in 2005. In contrast, catches of coho salmon were still strong when fish wheels operations ceased September 9 at the Kalskag site. Catch rates and fish wheel performance were excellent after relocating back to the Kalskag tagging site. It is believed that Chinook, sockeye, chum, and coho salmon were tagged in proportion to abundance throughout their migration.

Run Timing: Earlier tagged sockeye, chum, and coho salmon traveled further upstream than fish tagged later in the season a pattern seen since 2002. Chinook salmon also seem to exhibit this pattern, but not as pronounced.

Travel Speed: Travel speeds were similar between 2004 and 2005 for chum and sockeye salmon and for coho salmon at the George, Kogrukluk, and Takotna rivers. Travel speed was not similar between 2004 and 2005 for coho salmon at the Tatlawiksuk River. In general for all species except Chinook, travel speed increases the further a fish has to travel. Coho salmon marked later in the run showed an increase in travel speed from 2001 to 2005, with Chinook salmon displaying the same pattern in 2005. Travel speed characteristics may provide insights into behavior characteristics such as milling and homing behaviors.

Coho Run Abundance Estimate: An estimate of the total coho salmon run abundance upstream of the Kalskag site using the wheel-to-weir estimator was 640,736 (95% CI 547,011, 746,953; SE=52,541). The estimate was calculated using the Kalskag fish wheel and gillnet tag deployment and upstream escapement project data set.

RECOMMENDATIONS

- Continue tag deployment at the Kalskag tagging site upstream of the village of Kalskag, this area has provided locations where fish wheels are known to work effectively, increasing catches.
- Continue use of Floy® T-bar anchor tags to speed the tagging process, thereby allowing for more fish to be sampled.
- Increase the amount of effort spent gillnetting for tag deployment of Chinook, sockeye, chum, and coho salmon. Do not decrease the time spent drift gillnetting if fish wheel catches increase to a point beyond which staff can clear live boxes and need help from those gillnetting. Instead, maintain a consistent gillnetting effort by decreasing the time spent capturing salmon with fish wheels. Given the differences in stock composition between the two gear types sample sizes need to remain high in the gill net component.
- Expend effort in recovering tags from tributaries with little or no tag recovery effort, to increase the number of stocks used in run timing analysis.
- Expend effort in recapturing tags from the Aniak River, a major producer of salmon, for the purpose of obtaining tag proportions significant in determining bias for estimating abundance estimates.

- To mitigate the crowding effect on fish health, we recommend our sampling schedule be adjusted to decrease the number of fish held in live boxes. Further assessment is needed to better define the upper limits in the number of fish that corresponds to this effect.
- Continue to estimate coho salmon abundance with mark–recapture techniques involving tag deployment at Kalskag and recapture at upstream weirs. This is cost effective for estimating abundance as results of this project have been reasonable due in part to a good distribution of upstream weirs and a favorable marking location (Kalskag) with an existing platform of fish wheels and equipment with proximity to logistical support.
- Deploy radio tags on coho salmon to investigate spawning distribution and the proportion of salmon that move back downstream.
- Replace, as an alternative, anchor tags by using PIT tags to increase likelihood of tag recovery at weirs, eliminating missed tags due to visibility, crowding and human error.
- Compare 2001 through 2005 data sets using current year insights gain in probability of recapture, run timing, and bank orientation.

ACKNOWLEDGMENTS

The authors wish to acknowledge the Kuskokwim Native Association (KNA), United States Fish and Wildlife Service (USFWS), Office of Subsistence Management (OSM), Orutsararmiut Native Council (ONC), ADF&G Division of Sport Fish, and Association of Village Council President (AVCP) for providing support for this project. The authors would like to recognize and thank Calvin Simeon, Karrina Wooderson, and Samantha John, (KNA employees) for their help throughout this project. Their support and the support of KNA staff were essential to the project's success. In addition, the authors wish to acknowledge the KNA employees Victor Evan, Daryl Stewart, George Morgan, Duke Pensguard, Dwayne Morgan, Samantha Epchook, Randal Lang, Veronica Alexie, and Dave Cannon. We would also like thank the ONC employee Sonny Demientoff and AVCP fisheries biologist Eva Patton who were valued members of the tagging crew, as were ADF&G Commercial Fisheries employees Chad Bear, Andy Moore, Constantine Gregory, Philip Carscallen, Dan Costello, Cullen Lester and Division of Sport Fish employees Lisa Stuby, Loren St Amand, Glen Elliot, Virgil Davis, Kristy DeYoung, and student intern Julia Turner. Furthermore, we thank Doug Bue, Sara Gilk, and Bobbie Fisher from the ADF&G office in Bethel, Anica Estes, and Kelley Nyberg from the Anchorage office, and weir crews from USFWS, KNA, ONC, and ADF&G for collecting tag recovery information. We would also like to recognize Rich Cannon and Rod Campbell (USF&W OSM employees) and Ken Harper and Julie Laker with USFWS for their help and support. We thank Daniel Wheeler for operating the front-end loader to move fish wheels to and from the storage site to the river at the beginning and end of the project. We thank the Upper Kalskag Traditional Council, Upper Kalskag City Office, and Lower Kalskag Traditional Council for their advice, assistance, and support.

Lastly, we thank John Linderman and Doug Molyneaux for their supervisory support, Linda Brannian for project oversight, editorial comments, and critical reviews to improve the outcome of the project and this report, Vince McClain (USFWS) and Holly Krenz (ADF&G) for programming support, Katie Sechrist for editorial help, and Dan Bergstrom, John Hilsinger, and Gene Sandone for their support and expertise. Partial funding of this project was through USFWS Office of Subsistence and Management. The USFWS OSM provided $127,553 in funding support for this project (FIS 04-308) through the Fisheries Resource Monitoring Program, under agreement number 701814J569.

REFERENCES CITED

ADF&G (Alaska Department of Fish and Game). 1961a. Kuskokwim River salmon tagging studies, 1961. Arctic Yukon Kuskokwim Region Area 1961 Annual Management Report, Kuskokwim Stock Separation Report No. 1. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

ADF&G (Alaska Department of Fish and Game). 1961b. Yukon River salmon tagging studies, 1961. Arctic Yukon Kuskokwim Region Area 1961 Annual Management Report, Yukon Stock Separation Report No. 1. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

ADF&G (Alaska Department of Fish and Game). 1962. Kuskokwim River salmon tagging studies, 1962. Arctic Yukon Kuskokwim Region Area 1962 Annual Management Report, Kuskokwim Stock Separation Report No. 2. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

ADF&G (Alaska Department of Fish and Game). 1966. Kuskokwim River salmon tagging studies, 1966. Arctic Yukon Kuskokwim Region Area 1966 Annual Management Report, Kuskokwim Stock Separation Report No. 3. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

ADF&G (Alaska Department of Fish and Game). 1999. Research and prevention relative to the 1998 Bristol Bay, Kuskokwim, and Yukon River fishery resource disasters. Alaska Department of Fish and Game, Division of Commercial Fisheries, NOAA (National Oceanic and Atmospheric Administration) Cooperative Agreement NA96W0196, Juneau.

ADF&G (Alaska Department of Fish and Game). 2001. Alaska subsistence fisheries 1999 annual report. Alaska Department of Fish and Game, Division of Subsistence, Juneau.

ADF&G (Alaska Department of Fish and Game). 2002. Alaska subsistence fisheries 2000 annual report. Alaska Department of Fish and Game, Division of Subsistence, Juneau.

ADF&G (Alaska Department of Fish and Game). 2003a. Alaska subsistence fisheries 2001 annual report. Alaska Department of Fish and Game, Division of Subsistence, Juneau.

ADF&G (Alaska Department of Fish and Game). 2003b. Alaska subsistence fisheries 2002 annual report. Alaska Department of Fish and Game, Division of Subsistence, Juneau.

ADF&G (Alaska Department of Fish and Game). 2004. Escapement goal review of select AYK Region salmon stocks. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A04-01, Anchorage.

Barrett, B. M., F. M. Thompson and S. N. Wick. 1984a. Adult anadromous fish investigations: May-October 1983. Susitna Hydro Aquatic Studies. Report No. 1. Alaska Department of Fish and Game, Anchorage. APA Document # 1450.

Barrett, B. M., F. M. Thompson, and S. N. Wick. 1984b. Adult anadromous fish investigations: May-October 1984. Susitna Hydro Aquatic Studies. Report No. 6. Alaska Department of Fish and Game, Anchorage. APA Document # 2748.

Baxter, R. Unpublished. Holitna weir developmental project, 1976. AYK Region Kuskokwim Salmon Escapement Report No. 11. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Bergstrom, D. J., and C. Whitmore. 2004. Kuskokwim River Chinook and chum salmon stock status and action plan, a report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries. Regional Information Report No. 3A04-02, Anchorage.

Bernard, D. R., J. J. Hasbrouck, and S. J. Fleischman. 1999. Handling-induced delay and downstream movement of adult Chinook salmon in rivers. Fisheries Research 44:37-46.

Brown, C. M. 1983. Alaska's Kuskokwim River region: a history (draft). Bureau of Land Management, Anchorage.

Brownlee, K. M., S. A. McPherson, and D. L. Magnus. 1999. A mark-recapture experiment to estimate the escapement of Chinook salmon in the Blossom and Keta rivers, 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-45, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-45.pdf

REFERENCES CITED (Continued)

Bue, B. G. and J. J. Hasbrouck. 2001. Escapement goal review of salmon stocks of Upper Cook Inlet. Alaska Department of Fish and Game, Division of Sport Fish, Report to the Alaska Board of Fisheries, Anchorage.

Burkey, Jr., C. E., M. Coffing, D. B. Molyneaux, and P. Salomone. 2000. Kuskokwim River chum salmon stock status and development of management/action plan options, report to the Alaska Board of Fisheries. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A00-41, Anchorage.

Buzby K. and L. Deegan. 1999. Retention of anchor and passive integrated transponder tags by Arctic grayling. North American Journal of Fisheries Management 19:1147-1150.

Cappiello, T. A., and J. F. Bromaghin. 1997. Mark–recapture abundance estimate of fall-run chum salmon in the upper Tanana River, Alaska, 1995. Alaska Fishery Research Bulletin 4(1):12-35. Juneau.

Cappiello, T. A., and D. L. Bruden. 1997. Mark–recapture abundance estimate of fall-run chum salmon in the upper Tanana River, Alaska, 1996. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A97-37, Anchorage.

Carlon, J. A. 2000. Assessment of coho salmon from the Kenai River, Alaska, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 00-15, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds00-15.pdf

Chythlook, J. S., and M. J. Evenson. 2003. Assessment of Chinook, chum, and coho salmon escapements in the Holitna River drainage using radiotelemetry, 2002. Alaska Department of Fish and Game, Fishery Data Series No. 03-23, Anchorage http://www.sf.adfg.state.ak.us/FedAidPDFs/fds03-23.pdf

Cleary, P. M. and D. L. Bruden. 2000. Estimation of fall chum salmon abundance on the upper Tanana River using mark recapture techniques, 1998. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A00-03, Anchorage.

Cleary, P. M. and T. Hamazaki. 2002. Estimation of fall chum salmon abundance on the Tanana and Kantishna Rivers using mark–recapture techniques, 2000. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A02-17, Anchorage.

Clugston, J. P., 1996. Retention of t-bar anchor tags and passive integrated transponder tags by Gulf sturgeon. North American Journal of Fisheries Management 16:682-685.

Coffing, M., L. Brown, G. Jennings, and C. Utermohle. 2001. The subsistence and harvest use of wild resources in Achiachak, Alaska, 1998. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 258, Juneau.

Costello, D. J., D. B. Molyneaux, and C. Goods. 2006a. Takotna River Salmon Studies, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-26, Anchorage.

Costello, D. J., R. Stewart, D. B. Molyneaux, and D. Orabutt. 2006b. Tatlawiksuk River salmon studies, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-28, Anchorage.

Der Hovanisian, J. A., K. A. Pahlke, P. Etherton. 2003. Abundance of the chinook salmon escapement on the Stikine River, 2001. Alaska Department of Fish and Game, Fishery Data Series No. 03-09, Anchorage.

Eggers, D. M. 2001. Research and prevention relative to the 1998 Bristol Bay, Kuskokwim, and Yukon River fishery resource disasters, Revised scope of work. Alaska Department of Fish and Game, Division of Commercial Fisheries, NOAA (National Oceanic and Atmospheric Administration) Cooperative Agreement NA96W0196, Juneau.

Ericksen, R. P. 1999. Abundance of coho salmon in the Chilkat River in 1998. Alaska Department of Fish and Game, Fishery Data Series No. 99-29, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds99-29.pdf

Evenson, M. J., and K. G. Wuttig. 2000. Inriver abundance, spawning distribution, and migratory timing of Copper River Chinook salmon in 1999. Alaska Department of Fish and Game, Fishery Data Series No. 00-32, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds00-32.pdf

REFERENCES CITED (Continued)

Gilk, S.E. *Unpublished*. Kuskokwim River sockeye salmon radiotelemetry feasibility study, 2005. Located at: Alaska Department of Fish and Game, 333 Raspberry Rd., Anchorage, Alaska.

Gilk, S. E., W. D. Templin, D. B. Molyneaux, T. Hamazaki, and J. A. Pawluk. 2005. Characteristics of fall chum salmon in the Kuskokwim River Drainage. Alaska Department of Fish and Game, Fishery Data Series No. 05-56, Anchorage.

Groot, C. and L. Margolis (editors). 1991. Pacific salmon life histories. University of British Columbia Press, Vancouver.

Hammarstrom, S. L., and J. J. Hasbrouck. 1998. Estimation of the abundance of late-run Chinook salmon in the Kenai River based on exploitation rate and harvest, 1996. Alaska Department of Fish and Game, Fishery Data Series No.98-6, Anchorage.

Hammarstrom, S. L., and J. J. Hasbrouck. 1999. Estimation of the abundance of late-run Chinook salmon in the Kenai River based on exploitation rate and harvest, 1997. Alaska Department of Fish and Game, Fishery Data Series No. 99-8, Anchorage.

Harper, K. C., F. Harris, and D. Orabutt. *In prep*. Migrational timing and Seasonal distribution of Broad Whitefish, Humpback Whitefish, and Least Cisco from Whitefish Lake, Yukon Delta National Wildlife Refuge, Alaska. U.S. Fish and Wildlife Service, Kenai Fish and Wildlife Field Office, Alaska Fisheries Data Series, Kenai, Alaska.

Jasper, J. R, and D. B. Molyneaux. *In prep*. Kogrukluk River weir salmon studies, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-XX, Anchorage.

Jensen, K. A. and O. A. Mathisen. 1987. Migratory structure of the Kvichak River sockeye salmon (*Oncorhynchus nerka*) escapement, 1983. Canadian Special Publication of Fisheries and Aquatic Sciences 96:101-109.

Johnson, Y., I. Boyce, and B. Waugh. 2002. Estimation of the abundance of Chinook salmon (*Oncorhynchus tshawytscha*) in the Upper Yukon River Basin using mark–recapture methods: 1990 – 1995. Fisheries and Oceans Canada Science Branch, Canadian Technical Report of Fisheries and Aquatic Sciences 2378, Canada.

JTC (Joint Technical Committee, US/Canada Yukon River Panel). 2002. Yukon River salmon season review for 2002 and technical committee report. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A02-44, Anchorage.

Jones III, E. L., and S. A. McPherson. 1997. Relationship between observer counts and abundance of coho salmon in Steep Creek, Northern Southast Alaska in 1996. Alaska Department of Fish and Game, Fishery Data Series No. 97-25, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds97-25.pdf

Jones III, E. L., J. A. Weller, and A. B. Holm. 2001. Production of coho salmon from the Unuk River, 1999-2000. Alaska Department of Fish and Game, Fishery Data Series No. 01-14, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds01-14.pdf

Keefer, M. L., C. A. Peery, M. A. Jepson, K. R. Tolotti, and T. C. Bjornn. 2004. Stock-specific migration timing of adult spring-summer Chinook salmon in the Columbia River Basin. North American Journal of Fisheries Management 24:1145-1162.

Kerkvliet, C.M., and T. Hamazaki. 2003. A mark-recapture experiment to estimate the total population of Kuskokwim River coho salmon (*Oncorhynchus kisutch*), 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A02-15, Anchorage.

Kerkvliet, C. M., T. Hamazaki, K. E. Hyer and D. Cannon. 2003. A mark–recapture experiment to estimate the abundance of Kuskokwim River sockeye, chum and coho salmon, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A03-25, Anchorage.

Kerkvliet, C. M., J. Pawluk, T. Hamazaki, K. E. Hyer and D. Cannon. 2004. A mark–recapture experiment to estimate the abundance of Kuskokwim River sockeye, chum and coho salmon, 2003. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A04-14, Anchorage.

Killick, S. 1955. The chronological order of Fraser River sockeye salmon during migration, spawning and death. International Pacific Salmon Fisheries Commission Bulletin 7.

REFERENCES CITED (Continued)

Lebida, R. C. 1969. Yukon River king salmon tagging studies, 1963-1964. Arctic Yukon Kuskokwim Area Anadromous Fish Investigations, 1969 Annual Technical Report, Yukon Stock Separation Report No. 7. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Marino, T. and T. Otis. 1989. Pilot inventory of the Chinook Salmon (Oncorhynchus tshawytscha) stocks of the Kuskokwim River basin, Yukon Delta National Wildlife Refuge, 1989. U.S. Fish and Wildlife Service, Yukon Delta National Wildlife Refuge, Bethel.

McEwen, M. S. 2006 .Sonar estimation of chum salmon passage in the Aniak River, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-XX, Anchorage.

McPherson, S. A., B. J. Glynn, and E. L. Jones III. 1996. A mark–recapture experiment to estimate the escapement of coho salmon in Steep Creek, 1994. Alaska Department of Fish and Game, Fishery Data Series No. 96-31, Anchorage.

McPherson, S. A., D. R. Bernard, M. S. Kelley, P. A. Milligan, and P. Timpany. 1998. Spawning abundance of Chinook salmon in the Taku River in 1997. Alaska Department of Fish and Game, Fishery Data Series No. 98-41, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds98-41.pdf

Merritt, M. F., and K. Roberson. 1986. Migratory timing of upper Copper River sockeye salmon stocks and its implications for the regulation of the commercial fishery. North American Journal of Fisheries Management 6:216-225.

Molyneaux, D. B., L. K. Brannian, T. Hamazaki. *In prep*. Review of escapement and abundance information for Kuskokwim area salmon stocks. Alaska Department of Fish and Game, Fishery Manuscript, Anchorage.

Moody, D. W., E. B. Chase, and D. A. Aronson, (compilers). 1986. National water summary 1985—hydrologic events and surface-water resources: USGS Water-Supply Paper 2300, 506 p.

Parker, S. J. and R. L. Howard. 1995. Migratory behavior of adult chum salmon in the Kuskokwim River, 1995. Final Report. Bering Sea Fishermen's Association, Anchorage.

Pawluk, J., C.M. Kerkvliet, T. Hamazaki, K.E. Hyer and D. Orabutt. 2006. A mark–recapture study of Kuskokwim River sockeye, chum and coho salmon, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 06-52, Anchorage.

Regnart, R. I. 1962. Yukon River salmon tagging studies, 1962. Arctic Yukon Kuskokwim Region Area 1962 Annual Management Report, Yukon Stock Separation Report No. 2. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Regnart, R. I. 1964. Yukon River king salmon tagging studies, 1963-1964. Arctic Yukon Kuskokwim Region Area 1994 Annual Management Report, Yukon Stock Separation Report No. 3. Alaska Department of Fish and Game, Division of Commercial Fisheries, Anchorage.

Roettiger, T., F. G. Harris, and K. C. Harper. 2005. Abundance and run timing of adult Pacific salmon in the Kwethluk River, Yukon Delta National Wildlife Refuge, Alaska, 2004. U.S. Fish and Wildlife Service, Kenai Fish and Wildlife Field Office. Alaska Fisheries Data Series No. 2005-7, Kenai, Alaska.

Rowse, M. L. 1985. Migration timing of sockeye salmon (*Oncorhynchus nerka*) in the Wood River Lake system, Alaska. University of Washington, Master Thesis, Seattle.

Savereide, J. W. 2004. Inriver abundance, spawning distribution, and run timing of Copper River Chinook salmon in 2003. Alaska Department of Fish and Game, Fishery Data Series No. 04-26, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-26.pdf

Schwarz, C. J. and G. A. F. Seber. 1999. Estimating animal abundance: review III Statistical Science 14, 427-456.

REFERENCES CITED (Continued)

Seber, G. A. F. 1982. The estimation of animal abundance and related parameters, second edition. Edward Arnold, London.

Spencer, T., R. S. Chapell, T. Hamazaki, and J. H. Eiler. 2002. Estimation of abundance and distribution of Chinook salmon in the Yukon River using mark–recapture and radiotelemetry in 2000 and 2001. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A02-37, Anchorage.

Stewart, R., D. B. Molyneaux, D. J. Costello, and D. Orabutt. 2006. George River salmon studies, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-29, Anchorage.

Stroka, S. M., and A. L. J. Brase. 2004. Assessment of Chinook, chum, and coho salmon escapements in the Holitna River drainage using radiotelemetry, 2001- 2003. Final Report for Study 01-141 USFWS Office of Subsistence Management Fishery Information Service Division. Alaska Department of Fish and Game, Fishery Data Series No. 04-07, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds04-07.pdf

Stroka, S. M. and D. J. Reed. 2005. Assessment of Chinook and chum salmon escapements in the Holitna River drainage using radiotelemetry, 2004. Alaska Department of Fish and Game, Fishery Data Series No. 05-49, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds05-49.pdf

Stuby, L. 2005. Inriver abundance of Chinook salmon in the Kuskokwim River, 2002–2004. Alaska Department of Fish and Game, Fishery Data Series No. 05-39, Anchorage.

Stuby, L. 2006. Inriver abundance of Chinook salmon in the Kuskokwim River, 2005. Alaska Department of Fish and Game, Fishery Data Series No. 06-45, Anchorage.

Underwood, T. J., S. P. Klosiewski, J. L. Melegari, and R. J. Brown. 1998. Estimate of abundance of adult fall chum salmon in the upper Yukon River, Alaska, 1997. U. S. Fish and Wildlife Service, Alaska Fisheries Technical Report No. 56, Fairbanks.

Ward, T. C., M. Coffing, J. Estensen, R. L. Fisher, and D. B. Molyneaux. 2003. Annual management report for the subsistence and commercial fisheries of the Kuskokwim River, 2002. Alaska Department of Fish and Game, Division of Commercial Fisheries, Regional Information Report No. 3A03-27, Anchorage.

Whitmore, C., M. M. Martz, D. G. Bue, J. C. Linderman, and R. L. Fisher. 2005. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 2003. Alaska Department of Fish and Game, Fishery Management Report No. 05-72, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fmr05-72.pdf

Whitmore, C., M. Martz, J. C. Linderman, R. L. Fisher, and D. G. Bue. *In prep*. Annual management report for the subsistence and commercial fisheries of the Kuskokwim Area, 2004. Alaska Department of Fish and Game, Fishery Management Report, Anchorage.

Wuttig, K. G., and M. J. Evenson. 2002. Assessment of Chinook, chum, and coho salmon escapements in the Holitna River drainage using radiotelemetry, 2001. Alaska Department of Fish and Game, Fishery Data Series No. 02-05, Anchorage. http://www.sf.adfg.state.ak.us/FedAidPDFs/fds02-05.pdf

Zabkar, L. M., F. G. Harris, and K. C. Harper. 2005. Abundance and run timing of adult Pacific salmon in the Tuluksak River, Yukon Delta National Wildlife Refuge, Alaska, 2004. U.S. Fish and Wildlife Service, Kenai Fish and Wildlife Field Office. Alaska Fisheries Data Series No. 2005-6, Kenai, Alaska.

TABLES AND FIGURES

Table 1.–Distance to selected locations in the Kuskokwim River drainage.

Location [b]	Distance From River Mouth [a]		Distance from Bethel	
	Kilometer	Miles	Kilometer	Miles
Popokamiut (Downstream boundary District 1)	(3)	(2)	(109)	(68)
Kuskokwim River Mouth [c]	0	0	(106)	(66)
Apokak Slough (Downstream boundary District 1)	5	0	(106)	(66)
Eek River	13	8	(93)	(58)
Eek (community)	46	29	(60)	(37)
Kwegooyuk	22	13	(85)	(53)
Kinak River	32	20	(74)	(46)
Tuntutuliak (community)	45	28	(61)	(38)
Kialik River	50	31	(56)	(35)
Fowler Island	68	42	(39)	(24)
Johnson River	77	48	(29)	(18)
Napakiak (community)	87	54	(19)	(12)
Napaskiak (community)	97	60	(10)	(6)
Oscarville (community)	97	60	(10)	(6)
Bethel (community)	106	66	0	0
Gweek River	135	84	29	18
Kwethluk River	131	82	25	16
Kwethluk (community)	132	82	26	16
Kwethluk River Weir	216	134	109	68
Akiachak (community)	143	89	37	23
Kasigluk River	150	93	43	27
Kisaralik River	151	94	45	28
Akiak (community)	161	100	55	34
Mishevik Slough,	183	114	77	48
Tuluksak River	192	119	85	53
Tuluksak (community)	192	120	86	54
Tuluksak River Weir	248	154	142	88
Nelson Island	190	118	84	52
Bogus Creek (Upstream Boundary District 1)	203	126	97	60
High Bluffs	233	145	127	79
Downstream Boundary District 2	262	163	156	97
Mud Creek Slough	267	166	161	100
Lower Kalskag	259	161	153	95
Kalskag (community)	263	163	157	97
Lower Kalskag Fishwheel (2004)	249	155	143	89
Kalskag Fishwheel (2002, 2003, and 2005)	270	168	163	102

-continued-

Table 1.–Page 2 of 3.

Location [b]	Distance From River Mouth [a]		Distance from Bethel	
	Kilometer	Miles	Kilometer	Miles
Birchtree Fishwheel (2001 to 2004)	294	183	187	117
Aniak River	307	191	201	125
Aniak (community)	307	191	201	125
Aniak Receiver Site (upper)	310	191	201	125
Aniak Receiver Site (lower)	306	191	201	125
Aniak Sonar Site	323	201	217	135
Aniak Sonar Receiver Site	323	201	217	135
Chuathbaluk (community)	323	201	217	135
Upstream Boundary District 2	322	200	216	134
Kolmakof River	344	214	238	148
Napaimiut (community)	359	223	253	157
Holokuk River	362	225	256	159
Sue Creek	381	237	275	171
Oskawalik River	398	247	291	181
Crooked Creek (community)	417	259	311	193
Georgetown (community)	446	277	340	211
George River	446	277	340	211
George River Weir	453	281	347	215
George Receiver Site	453	281	347	215
Red Devil (community)	472	293	365	227
Red Devil Receiver Site	472	293	365	227
Sleetmute (community)	488	303	381	237
Holitna River	491	305	385	239
Hoholitna River	538	334	432	268
Chukowan River	709	441	603	375
Kogrukluk River	709	441	603	375
Kogrukluk River Weir	710	441	604	375
Kogrukluk Receiver Site	710	441	604	375
Stony River (community)	534	332	428	266
Stony River	536	333	430	267
Lime Village (community)	644	400	538	334
Telaquana River	727	452	621	386
Telaquana Lake (outlet)	756	470	650	404
Swift River	560	348	454	282
Moose Creek	533	331	426	265
Cheeneetnuk River	587	365	481	299
Gagarayah River	634	394	528	328
Babel River	660	410	554	344
Selatna River	663	412	557	346

-continued-

Table 1.–Page 3 of 3.

Location [b]	Distance From River Mouth [a]		Distance from Bethel	
	Kilometer	Miles	Kilometer	Miles
Little Selatna River	669	416	563	350
Black River	679	422	573	356
Nunsatuk River	620	385	513	319
Katitna River	719	447	613	381
Blackwater River	838	521	732	455
Tatlawiksuk River	563	350	457	284
Tatlawiksuk River Weir	568	353	462	287
Tatlawiksuk Receiver Site	568	353	462	287
Devil's Elbow	599	372	492	306
Vinasale (abandoned community)	665	413	558	347
Takotna River	752	467	645	401
Takotna (community)	832	517	726	451
Takotna River Weir	835	519	729	453
Takotna Receiver Site	835	519	729	453
McGrath (community)	753	468	647	402
McGrath Receiver Site	753	468	647	402
Middle Fork	806	501	700	435
Big River	827	514	721	448
Pitka Fork	845	525	739	459
Medfra (community)	863	536	756	470
South Fork	869	540	763	474
East Fork	882	548	776	482
North Fork	884	549	777	483
Nikolai (community)	941	585	835	519
Swift Fork	1,078	670	972	604
Telida (community)	1,128	701	1,022	635
Highpower Creek	1,151	715	1,044	649
Headwaters South Fork	1,292	803	1,186	737
Headwaters North Fork	1,548	962	1,442	896

Note: Distances are determined using a computer version (Garmin Topo MapSource) of U.S. Geological Survey 1:100,000 scale maps. Routing is as if traveling by boat**.** Distances to radiotelemetry tracking stations are approximate.

[a] The "mouth" of the Kuskokwim River is defined as the southern most tip of Eek Island (latitude N 60° 05.569, longitude W 162° 19.054), and is one of three points that define the downstream boundary of District 1.

[b] Locations not on the mainstem of the Kuskokwim River are listed as subordinate to the point of departure from the mainstem.

Table 2.–Number of salmon anchor tagged at the Kalskag tagging site, 2005.

	Number of Salmon			
Tagging Location	**Tagged**	**Not Tagged**	**Total Catch**	**Recapture [a]**
Chinook				
Right Bank #1 [b]	173	2	175	1
Right Bank #2 [b]	176	6	182	5
Left Bank [c]	503	4	507	3
Gillnet	346	1	347	2
Total	1,198	13	1,211	11
			0	
Sockeye			0	
Right Bank #1 [b]	2,438	126	2,564	42
Right Bank #2 [b]	847	88	935	47
Left Bank [c]	1,243	15	1,258	50
Gillnet	120	4	124	1
Total	4,648	233	4,881	140
			0	
Chum			0	
Right Bank #1 [b]	14,405	990	15,395	230
Right Bank #2 [b]	7,240	922	8,162	612
Left Bank [c]	6,303	173	6,476	538
Gillnet	468	33	501	3
Total	28,416	2,118	30,534	1,383
Coho				
Right Bank #1 [b]	3,052	141	3,193	22
Right Bank #2 [b]	892	45	937	29
Left Bank [c]	1,198	18	1,216	43
Gillnet	370	7	377	2
Total	5,512	211	5,723	96

[a] Recapture of a tagged fish.
[b] Fish wheel anchored to the right bank.
[c] Fish wheel anchored to the left bank.

Table 3.–Number of anchor-tagged salmon recovered at escapement projects, 2005.

Recovery Location	Distance[a] (rkm)	Observed Escapement	Source of Tagging: Fish wheel	Gillnet	Unknown[b]	Total	Tag Ratio[c]
Chinook Salmon							
Takotna R. Weir	565	506	3	0	0	3	0.006
Kogrukluk R. Weir	440	21,731	59	40	5	104	0.005
Tatlawiksuk R. Weir	298	2,861	12	4	0	16	0.006
George R. Weir	183	3,845	6	5	2	13	0.003
Upstream Subtotal		28,943	80	49	7	136	0.005
Tuluksak R. Weir	-134	2,653	0	0	3	3	0.001
Total		31,596	80	49	10	139	0.004
Sockeye Salmon							
Takotna R. Weir	565	35	2	0	0	2	0.057
Kogrukluk R. Weir	440	37,465	209	5	16	230	0.006
Tatlawiksuk R. Weir	298	74	3	0	0	3	0.041
George R. Weir	183	272	15	0	2	17	0.063
Upstream Subtotal		37,846	229	5	18	252	0.007
Tuluksak R. Weir	-134	642	20	0	10	30	0.047
Total		38,488	249	5	28	282	0.007
Chum Salmon							
Takotna R. Weir	565	6,472	6	0	0	6	0.001
Kogrukluk R. Weir	440	191,588	169	7	9	185	0.001
Tatlawiksuk R. Weir	298	55,316	154	6	9	169	0.003
George R. Weir	183	14,654	259	3	33	295	0.020
Aniak R. Sonar	53	2,875	20	0	0	20	0.007
Upstream Subtotal		270,905	608	16	51	675	0.002
Tuluksak R. Weir	-134	35,696	26	0	19	45	0.001
Total		306,601	634	16	70	720	0.002
Coho Salmon							
Takotna R. Weir	565	2,216	13	1	1	15	0.007
Kogrukluk R. Weir	440	23,102	191	9	8	208	0.009
Tatlawiksuk R. Weir	298	6,746	28	3	1	32	0.005
George R. Weir	183	8,197	74	4	6	84	0.010
Upstream Subtotal		40,261	306	17	16	339	0.008
Tuluksak R. Weir	-134	11,324	2	0	3	5	<0.001
Total		51,585	308	17	19	344	0.007

[a] Distance from Kalskag tagging site.

[b] Capture gear unknown, tags observed but not recovered.

[c] Tag ratio is proportion of observed tags at a project relative to the total observed escapement at that project, by species.

Table 4.–Number of anchor-tagged salmon recovered by subsistence, commercial, and sport fishers, 2005.

		Tags Recovered				
		Subsistence	**Commercial**	**Sport**	**Other** [a]	**Total**
Chinook						
	>50 rkm	19	0	1	0	20
	-50 rkm to 50 rkm	11	2	1	0	14
	<-50 rkm	2	0	0	0	2
	Total	32	2	2	0	36
Sockeye						
	>50 rkm	16	0	2	4	22
	-50 rkm to 50 rkm	21	1	2	0	24
	<-50 rkm	13	24	0	1	38
	Total	50	25	4	5	84
Chum						
	>50 rkm	44	0	16	33	93
	-50 rkm to 50 rkm	66	2	11	15	94
	<-50 rkm	27	30	1	0	58
	Total	137	32	28	48	245
Coho						
	>50 rkm	18	0	5	7	30
	-50 rkm to 50 rkm	59	0	17	0	76
	<-50 rkm	22	49	5	2	78
	Total	99	49	27	9	184

[a] "Other" includes recovery sources such as tags found on carcasses deposited on gravel bars.

Table 5.–Stock-specific timing of anchor-tagged salmon at tributary escapement projects, 2005.

Recovery Location	Distance [a] (rkm)	No. of Recovered Tags	Observed Escapement	Median Tagging Date [b]	Median Recovery Date [c]	Median Observed Escapement Date [d]
Chinook Salmon [e]						
Takotna R. Weir	565	3	506	14-Jun	9-Jul	11-Jul
Kogrukluk R. Weir	440	99	21,731	20-Jun	15-Jul	13-Jul
Tatlawiksuk R. Weir	298	16	2,861	20-Jun	6-Jul	7-Jul
George R. Weir	183	11	3,845	22-Jun	4-Jul	4-Jul
Sockeye Salmon						
Takotna R. Weir	565	2	35	15-Aug	29-Aug	17-Aug
Telaquana Lk.	486	4	---	2-Jul	---	---
Kogrukluk R. Weir	440	214	37,465	4-Jul	21-Jul	15-Jul
Tatlawiksuk R. Weir	298	3	74	19-Jul	30-Jul	30-Jul
George R. Weir	183	16 [f]	272	9-Aug	19-Aug	13-Aug
Chum Salmon						
Takotna R. Weir	565	6	6,472	3-Jul	18-Jul	16-Jul
Kogrukluk R. Weir	440	176	191,588	5-Jul	18-Jul	20-Jul
Tatlawiksuk R. Weir	298	162 [f]	55,316	7-Jul	15-Jul	15-Jul
George R. Weir	183	296 [f]	14,654	20-Jul	26-Jul	14-Jul
Oskawalik R.	128	27 [f]	---	28-Jul	---	---
Aniak R. Sonar	53	21 [f]	2,875	27-Jul	29-Jul	26-Jul
Coho Salmon						
Takotna R. Weir	565	14	2,216	6-Aug	3-Sep	27-Aug
Kogrukluk R. Weir	440	200	23,102	16-Aug	8-Sep	3-Sep
Tatlawiksuk R. Weir	298	31	6,746	17-Aug	31-Aug	24-Aug
George R. Weir	183	78	8,197	29-Aug	7-Sep	31-Aug

[a] Distance of escapement project is relative to the Kalskag tagging site.
[b] Median tagging date of recovered tags.
[c] Median recovery date of recovered tags.
[d] Median date of the total weir or sonar escapement count.
[e] Includes both radio- and anchor-tagged Chinook salmon.
[f] Weighted (includes recoveries of fish weighted as more than 1 fish).

Table 6.–Stock-specific travel speed of anchor-tagged salmon, 2005.

Recapture Location	Distance [a] (rkm)	Number Recovered	Range of Tagging Dates [b]	Travel Speed (rkm/day) Mean	SD	Travel Days Mean	Range
Chinook Salmon							
Takotna R. Weir	565	3	June 5 – Jun 18	22	7.3	29	20–41
Kogrukluk R. Weir	440	99	June 6 – Sept. 3	22	7.5	22	10–43
Tatlawiksuk R. Weir	298	16	June 4 – July 7	20	9.8	18	6–31
George R. Weir	183	11	June 13 – Aug. 30	21	6	9	6–12
Sockeye Salmon							
Takotna R. Weir	565	2	Aug 14 – Aug 16	40	9.8	15	12–17
Kogrukluk R. Weir	440	214	June 9 – Aug 19	26	7.8	18	5–38
Tatlawiksuk R. Weir	298	3	July 10 – July 23	25	4.2	12	11–15
George R. Weir	183	15	July 6 – Aug 29	24	8.7	9	5–22
Chum Salmon							
Takotna R. Weir	565	6	June 20 – July 8	39	3.5	15	13–17
Kogrukluk R. Weir	440	176	June 19 – Aug. 30	34	5.6	13	7–25
Tatlawiksuk R. Weir	298	160	June 19 – Aug. 6	36	5.8	9	6–15
George R. Weir	183	262	June 14 – Sept. 9	33	12	6	1–22
Aniak Sonar	53	20	June 23 – Aug. 17	19	5.4	3	2–5
Coho Salmon							
Takotna R. Weir	565	14	July 28 – Aug. 28	26	6.4	23	14–32
Kogrukluk R. Weir	440	200	July 21 – Sept. 9	24	6.5	20	11–42
Tatlawiksuk R. Weir	298	31	July 31 – Sept. 8	23	6.9	14	7–23
George R. Weir	183	77	Aug 4 – Sept. 9	20	7.7	11	5–24

[a] Distance of escapement project is relative to the Kalskag tagging site.

[b] Date fish were tagged at Kalskag site.

Table 7.–Estimates of coho salmon abundance in the Kuskokwim River upstream of the Kalskag tagging site based on either tag recovery from gillnets and fish wheels near Aniak (wheel-to-wheel) or tag recovery from tributary escapement monitoring projects (wheel-to-weir).

	Wheel-to-wheel [a, b]				Wheel-to-weir [c]					
			95% CI				95% CI			
Year	**Estimate**	**SE**	**Lower**	**Upper**	**Estimate**	**SE**	**Lower**	**Upper**	**CV**	**P-value**
2001	na				434,604	56,269	339,815	557,647	0.10	0.014
2002	316,068	62,342	193,877	438,259	425,728	38,609	361,082	503,327	0.06	0.182
2003	849,494	99,649	654,182	1,044,806	928,075	61,718	818,805	1,065,557	0.03	0.154
2004	386,743	42,806	303,995	469,491	1,529,631	193,662	1,200,763	1,964,886	0.09	0.705
2005	na				640,736	52,541	547,011	746,953	0.06	0.092

[a] Spaghetti tags were used from 2001 to 2004 and anchor tags in 2005.

[b] Abundance estimate using tags released at Kalskag and recovered near Aniak in the mainstem Kuskokwim River.

[c] Abundance estimates based on tags released near Kalskag and recovered at upstream tributary monitoring projects.

Table 8.–Number of salmon examined for secondary marks at tributary escapement projects, 2005.

Tag Recovery Location	Chinook		Sockeye		Chum		Coho	
	Examined	Missing Tag [a]	Examined	Missing Tag [a]	Examined	Missing Tag [a]	Examined	Missing Tag [a]
Takotna R. Weir	213	0	2	0	1,107	0	1,059	0
Kogrukluk R. Weir	902	0	268	0	2,067	1	1,040	0
Tatlawiksuk R. Weir	472	0	13	0	2,583	0	1,409	0
George R. Weir	526	1	73	0	1,689	1	1,329	0
Total	2,113	1	356	0	7,446	2	4,837	0

[a] Number of fish examined that had a secondary mark, but no anchor tag.

Table 9.–Contingency table analysis comparing marked to unmarked ratios of coho salmon counted at the Takotna, Kogrukluk, Tatlawiksuk, and George River weirs, 2005.

Recapture Site	Unmarked	Marked[a]	%
Takotna R. Weir	2,201	13	0.59
Kogrukluk R. Weir	22,894	165	0.72
Tatlawiksuk R. Weir	6,714	30	0.45
George R. Weir	8,114	59	0.73
Total	39,923	267	0.67

$\chi 2$= 6.323, df= 3, P= 0.0969

[a] Denotes only those fish that were tagged from both right bank fish wheels and drift gillnets.

Table 10.–Estimates of salmon at various Kuskokwim River tributaries and statistics from the Kuskokwim River salmon mark–recapture project, 2001–2005.

Project	Distance [a] (rkm)	2001	2002	2003	2004	2005
Chinook Salmon						
Takotna R. Weir	565		316	378	462	506
Kogrukluk R. Weir	440		10,104	11,771	19,651	22,000
Tatlawiksuk R. Weir	298		2,237	1,683	2,833	2,920
George R. Weir	183		2,444	4,693	5,207	3,845
Tags Recovered weir/sonar	---		----	----	----	139
Kalskag fish wheel catch	0		759	946	1,016[b]	856[c]
Tuluksak R. Weir	-134		1,346	1,046	1,475	2,653
Kwethluk R. Weir	-224		8,502	14,474	28,605	----
Sockeye Salmon						
Kogrukluk R. Weir	440		4,050	9,164	6,767	37,939
Tags recovered at weirs/sonar	---		14	61	60	255
Kalskag fish wheel catch	0		295	1,478	1,885[b]	5,035[c]
Kuskokwim R. above Kalskag [d]	0			90,449	----	----
Kwethluk R. weir	-224		272	2,928	3,303	----
Chum Salmon						
Takotna R. weir	565		4,366	3,393	1,633	6,472
Kogrukluk R. weir	440		51,570	23,411	24,201	197,723
Tatlawiksuk R. weir	298		24,542	----	21,245	55,721
George R. weir	183		6,543	33,666	14,411	14,828
Aniak R. sonar[e]	53		472,346	477,544	672,931	1,151,505
Tags Recovered weir/sonar	---		179	302	97	650
Kalskag fish wheel catch	0		7,822	9,732	5,896[b]	32,010[c]
Kuskokwim R. above Kalskag [d]	0		675,659	412,443	----	----
Tuluksak R. weir	-134		9,958	11,724	11,796	35,696
Kwethluk R. weir	-224		35,854	41,812	38,646	----
Coho Salmon						
Takotna R. weir	565	3,957	3,984	7,171	3,207	2,216
Kogrukluk R. weir	440	19,387	14,516	74,754	27,041	24,116
Tatlawiksuk R. weir	298	10,539	11,363	----	16,410	7,559
George R. weir	183	14,415	6,759	33,280	13,248	8,200
Tags recovered weirs/sonar	---	233	249	850	118	324
Kalskag fish wheel catch	0	1,366	3,075	7,288	3,087[b]	5,884[c]
Kuskokwim R. above Kalskag [f]	0	434,604	425,728	928,075	1,529,631[b]	640,736[c]
Kuskokwim R. above Kalskag [g]	0	---	316,068	849,494	386,743[b]	---
Tuluksak R. weir	-134	23,768	11,487	41,071	20,336	11,324
Kwethluk R. weir	-224	21,596	23,298	107,789	64,216	---

[a] Distance of escapement project is relative to the Kalskag tagging site.
[b] Lower Kalskag tagging site.
[c] Additional right bank fish wheel.
[d] Kuskokwim River mark–recapture project abundance estimate.
[e] Counts have been adjusted to be representative of DIDSON equipment (Molyneaux et al. *In prep*)
[f] Kuskokwim River mark–recapture project, fish wheel-to-weir abundance estimate.
[g] Kuskokwim River mark–recapture project, fish wheel-to-wheel abundance estimate.

Table 11.–Number of anchor-tagged salmon recovered at escapement projects by gear type used at the Kalskag site, 2005.

			Tagging Source								
			Fish Wheel								
			Right Bank #1		Right Bank #2		Left Bank		Drift Gillnets		Total[c]
Recovery Source	Distance [a] (rkm)	Observed Escapement	n	% [b]	n	% [b]	n	% [b]	n	% [b]	n
Chinook											
Tagged at Kalskag	0		173	14.4	176	14.7	503	42.0	346	28.9	1,198
Takotna Weir	565	506	0	0.0	1	33.3	2	66.7	0	0.0	3
Kogrukluk Weir	440	21,731	7	7.1	8	8.1	44	44.4	40	40.4	104
Tatlawiksuk Weir	298	2,861	3	18.8	4	25.0	5	31.3	4	25.0	18
George R. Weir	183	3,845	2	18.2	2	18.2	2	18.2	5	45.5	11
Upstream Total		28,943	12	9.3	15	11.6	53	41.1	49	38.0	136
Tuluksak Weir	-134	2,653	0		0		0		0		3
Sockeye											
Tagged at Kalskag	0		2,438	52.5	847	18.2	1,243	26.7	120	2.6	4,648
Takotna Weir	565	35	1	50.0	0	0.0	1	50.0	0	0.0	2
Kogrukluk Weir	440	37,465	116	54.2	57	26.6	36	16.8	5	2.3	214
Tatlawiksuk Weir	298	74	2	66.7	0	0.0	1	33.3	0	0.0	19
George Weir	183	272	11	73.3	2	13.3	2	13.3	0	0.0	17
Upstream Subtotal		37,846	130	55.6	59	25.2	40	17.1	5	2.1	252

-continued-

Table 11.–Page 2 of 2.

			Tagging Source								
			Fish Wheel								
			Right Bank #1		Right Bank #2		Left Bank		Drift Gillnets		Total[c]
Recovery Source	Distance [a] (rkm)	Observed Escapement	n	% [b]	n	% [b]	n	% [b]	n	% [b]	n
Tuluksak Weir	-134	642	12	60.0	6	30.0	2	10.0	0	0.0	30
Chum											
Tagged at Kalskag	0		14,405	50.7	7,240	25.5	6,303	22.2	468	1.6	28,416
Takotna Weir	565	6,472	4	66.7	2	33.3	0	0.0	0	0.0	6
Kogrukluk Weir	440	191,588	115	65.3	34	19.3	20	11.4	7	4.0	185
Tatlawiksuk Weir	298	55,316	95	59.4	34	21.3	25	15.6	6	3.8	169
George Weir	183	14,654	131	50.0	68	26.0	60	22.9	3	1.1	295
Aniak Sonar	52	2,875	7	35.0	4	20.0	9	45.0	0	0.0	20
Upstream Subtotal		270,905	352	56.4	142	22.8	114	18.3	16	2.6	675
Tuluksak Weir	-134	35,696	95	70.4	34	25.2	6	4.4	0	0.0	154
Coho											
Tagged at Kalskag	0		3,052	55.4	892	16.2	1,198	21.7	370	6.7	5,512
Takotna Weir	565	2,216	8	57.1	3	21.4	2	14.3	1	7.1	15
Kogrukluk Weir	440	23,102	116	58.0	34	17.0	41	20.5	9	4.5	201
Tatlawiksuk Weir	298	6,746	18	58.1	8	25.8	2	6.5	3	9.7	39
George Weir	183	8,197	43	55.1	9	11.5	22	28.2	4	5.1	84
Upstream Subtotal		40,261	185	57.3	54	16.7	67	20.7	17	5.3	339
Tuluksak R. Weir	-134	11,324	1	50.0	0	0.0	1	50.0	0	0.0	2

[a] Distance from Kalskag tagging site.

[b] By recovery location the percent recoveries that were tagged from here.

[c] Includes tags for which tagging gear and site is unknown (tag observed but not recovered). Percent by location based only on recovered tags.

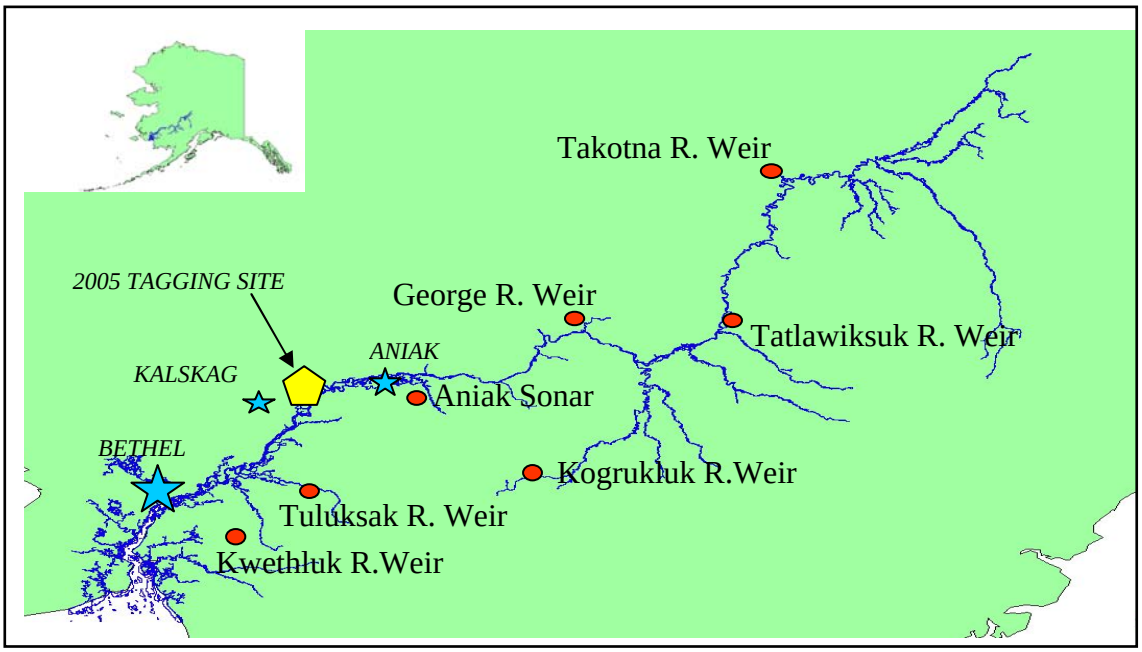


Figure 1.–Locations of tagging and weirs sites on the Kuskokwim River, 2005.

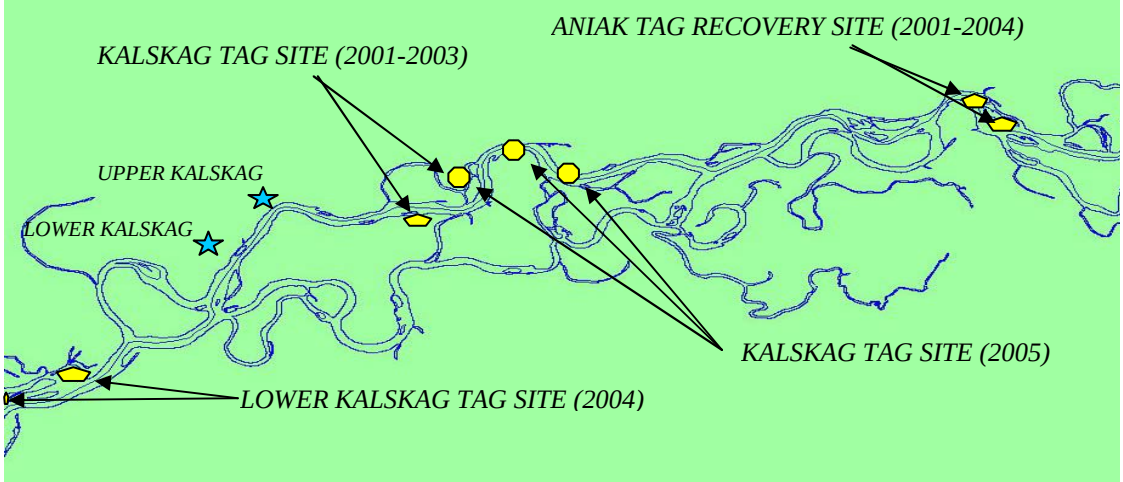


Figure 2.-Location of fish wheels at tagging sites on the Kuskokwim River, 2002-2005.

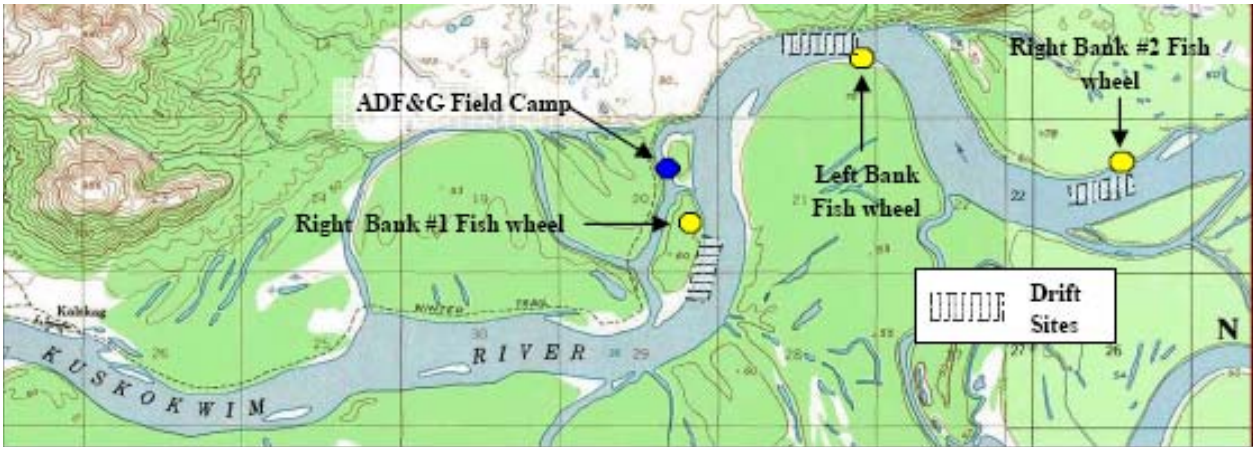


Figure 3.–Detailed map of 2005 fish wheel and drift gillnet locations.

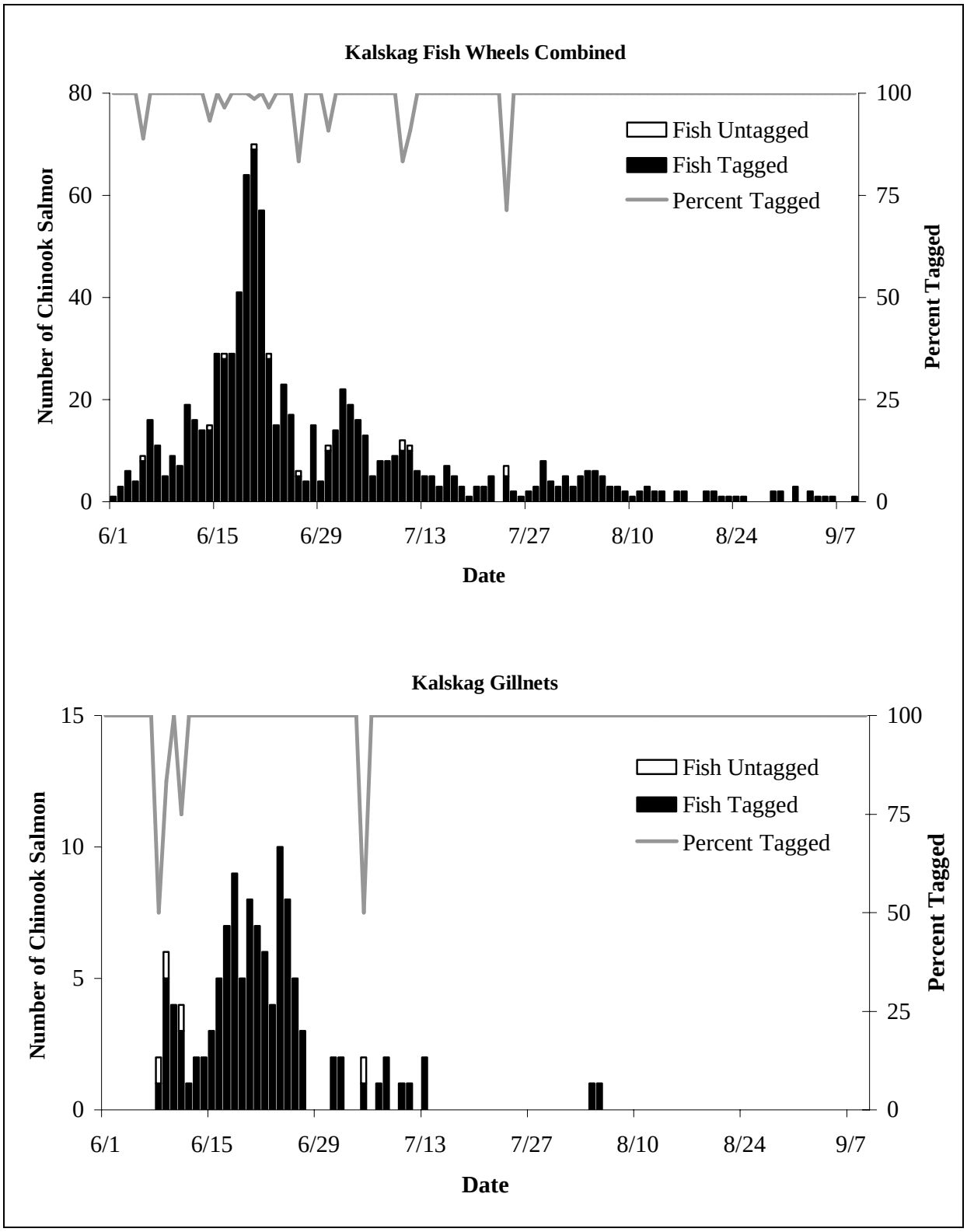


Figure 4.–Number of Chinook salmon tagged by date compared to the percent of Chinook salmon tagged at the Kalskag site on the Kuskokwim River, 2005.

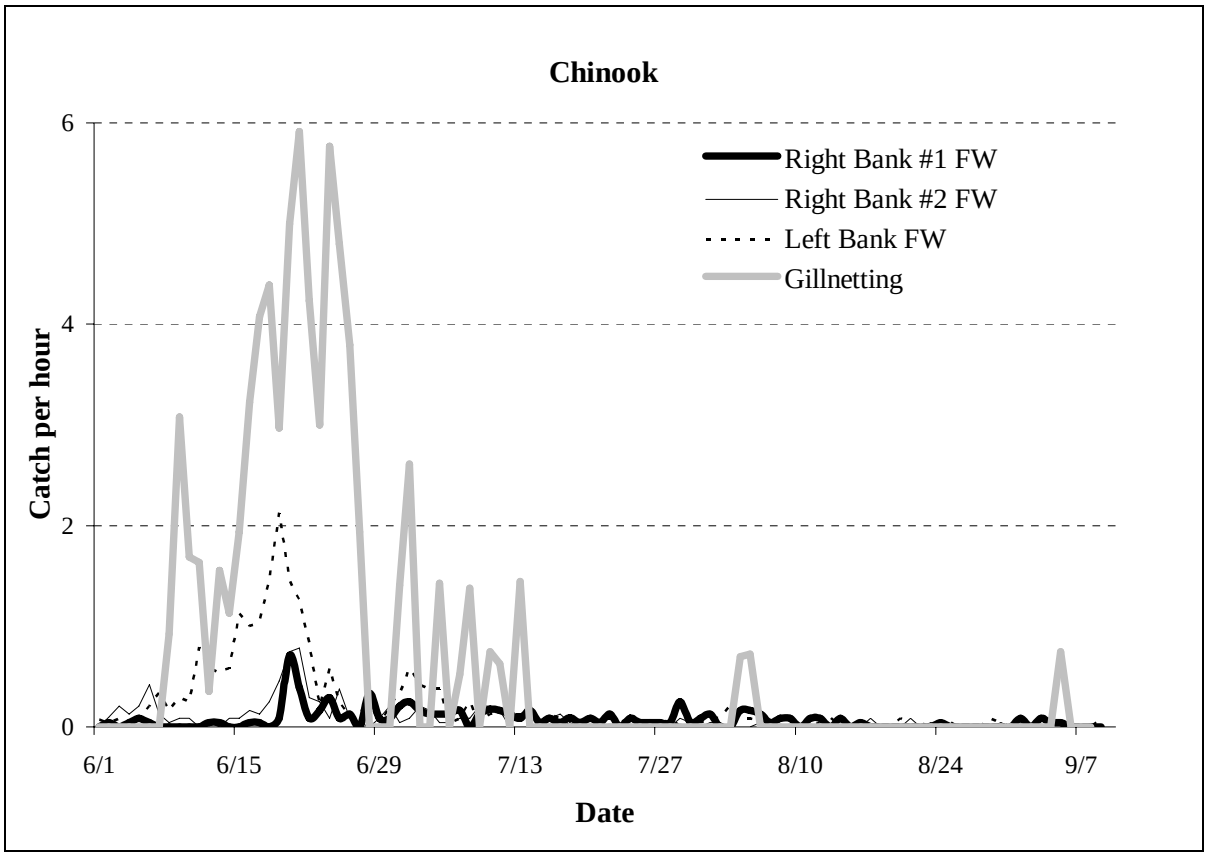


Figure 5.–Catch per hour of Chinook salmon from fish wheels (FW) and drift gillnets on the Kuskokwim River, 2005.

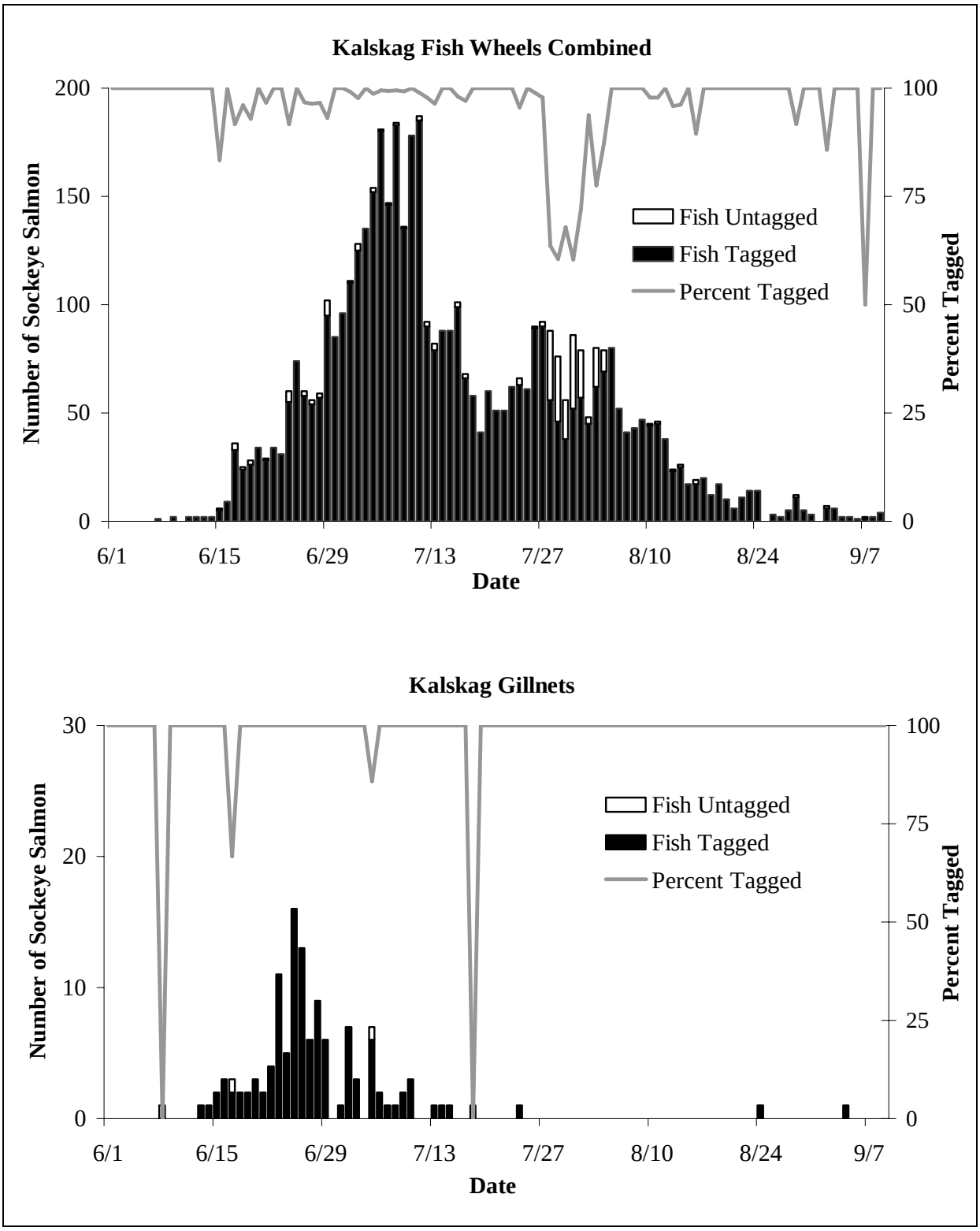


Figure 6.–Number of sockeye salmon tagged by date compared to the percent of sockeye salmon tagged at the Kalskag site on the Kuskokwim River, 2005.

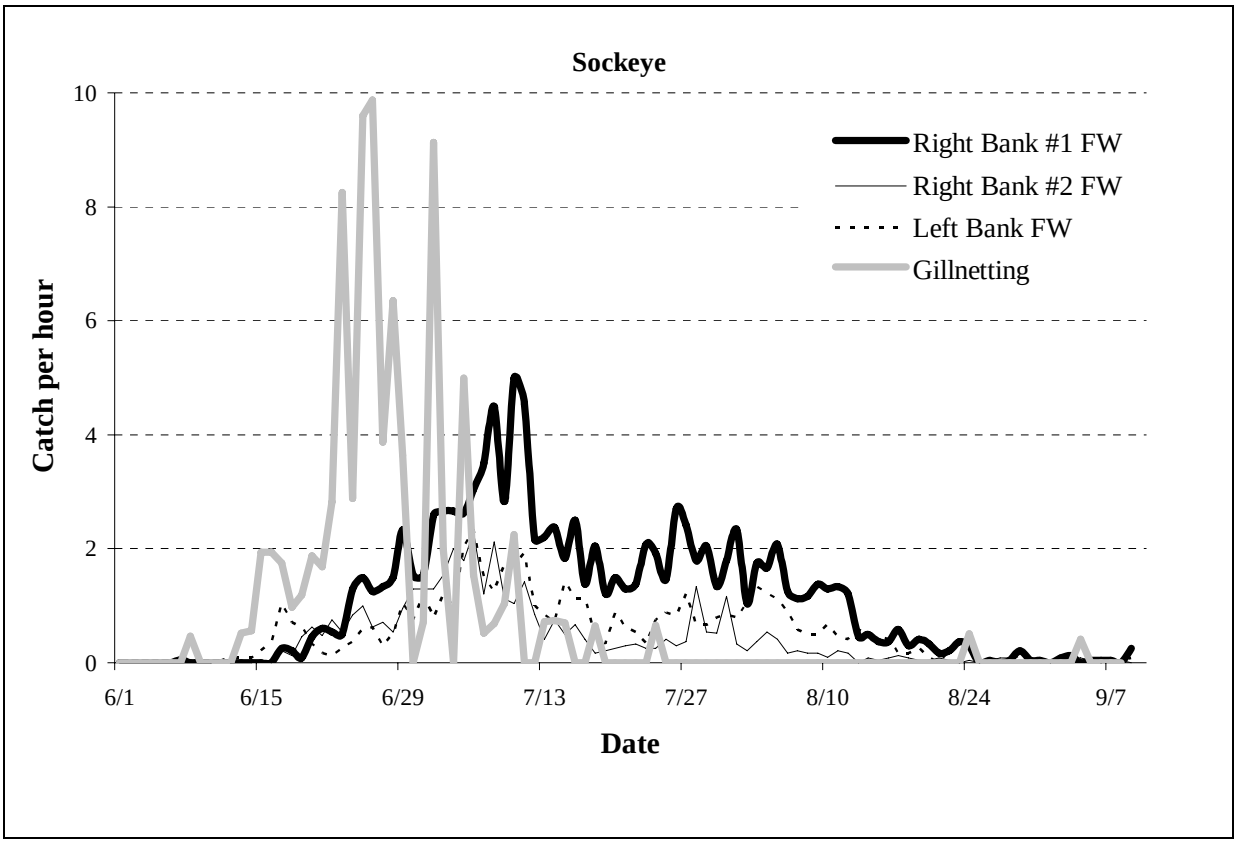


Figure 7.–Catch per hour of sockeye salmon from fish wheels (FW) and drift gillnets on the Kuskokwim River, 2005.

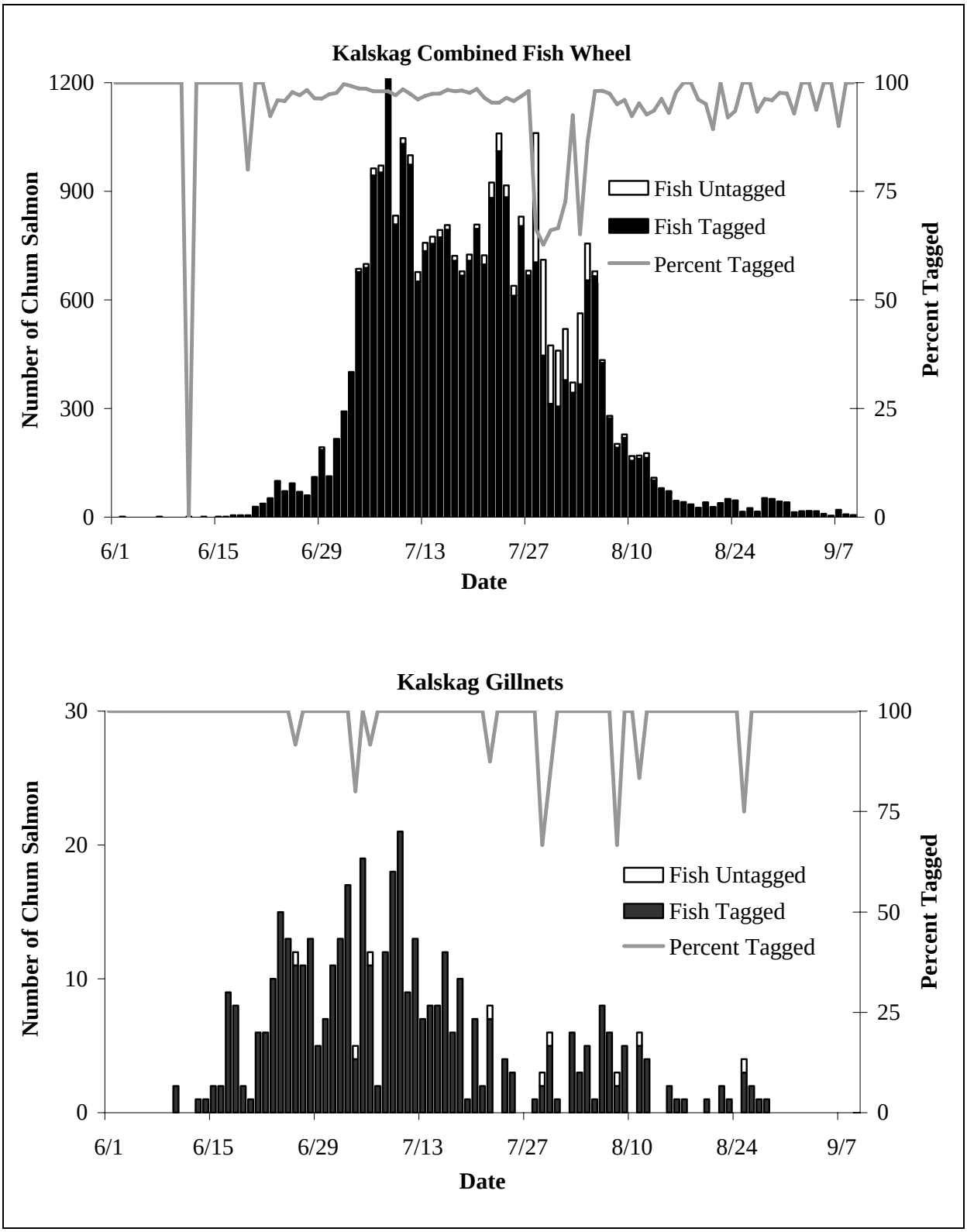


Figure 8.–Number of chum salmon tagged by date compared to the percent of chum salmon tagged at the Kalskag site on the Kuskokwim River, 2005.

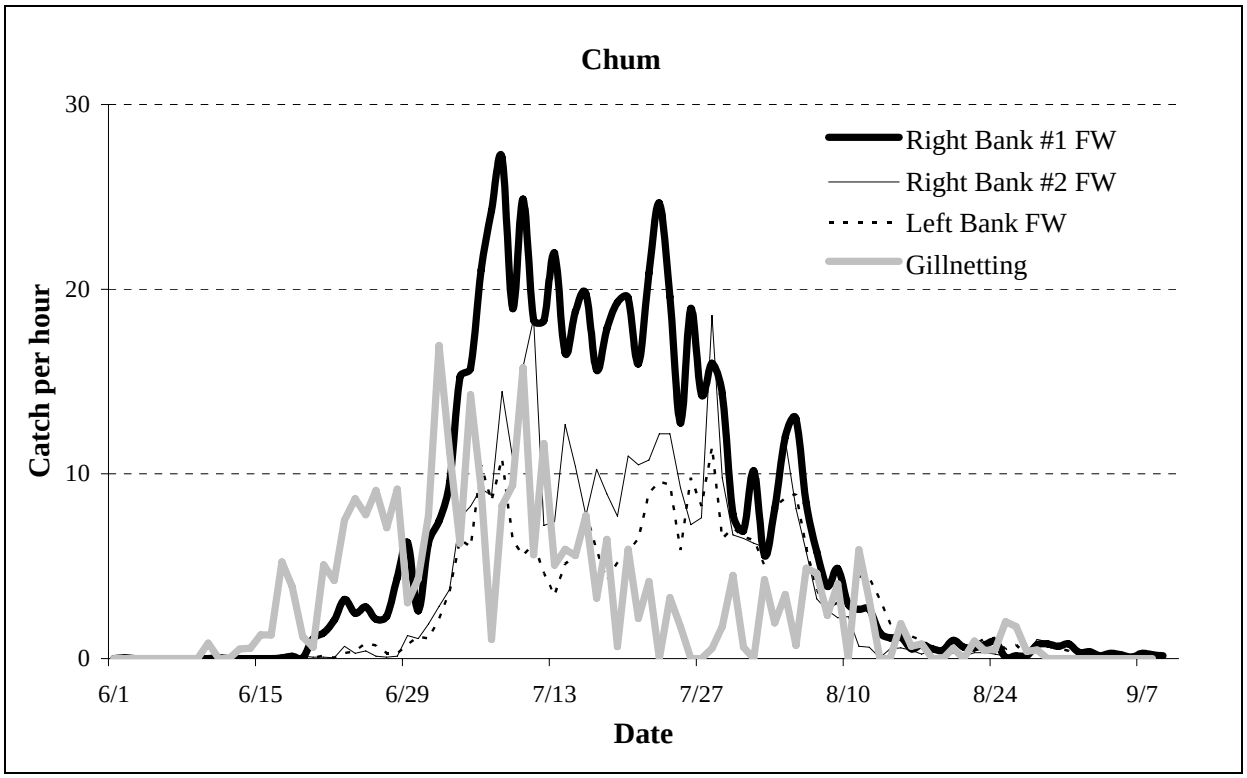


Figure 9.–Catch per hour of chum salmon from fish wheels (FW) and drift gillnets on the Kuskokwim River, 2005.

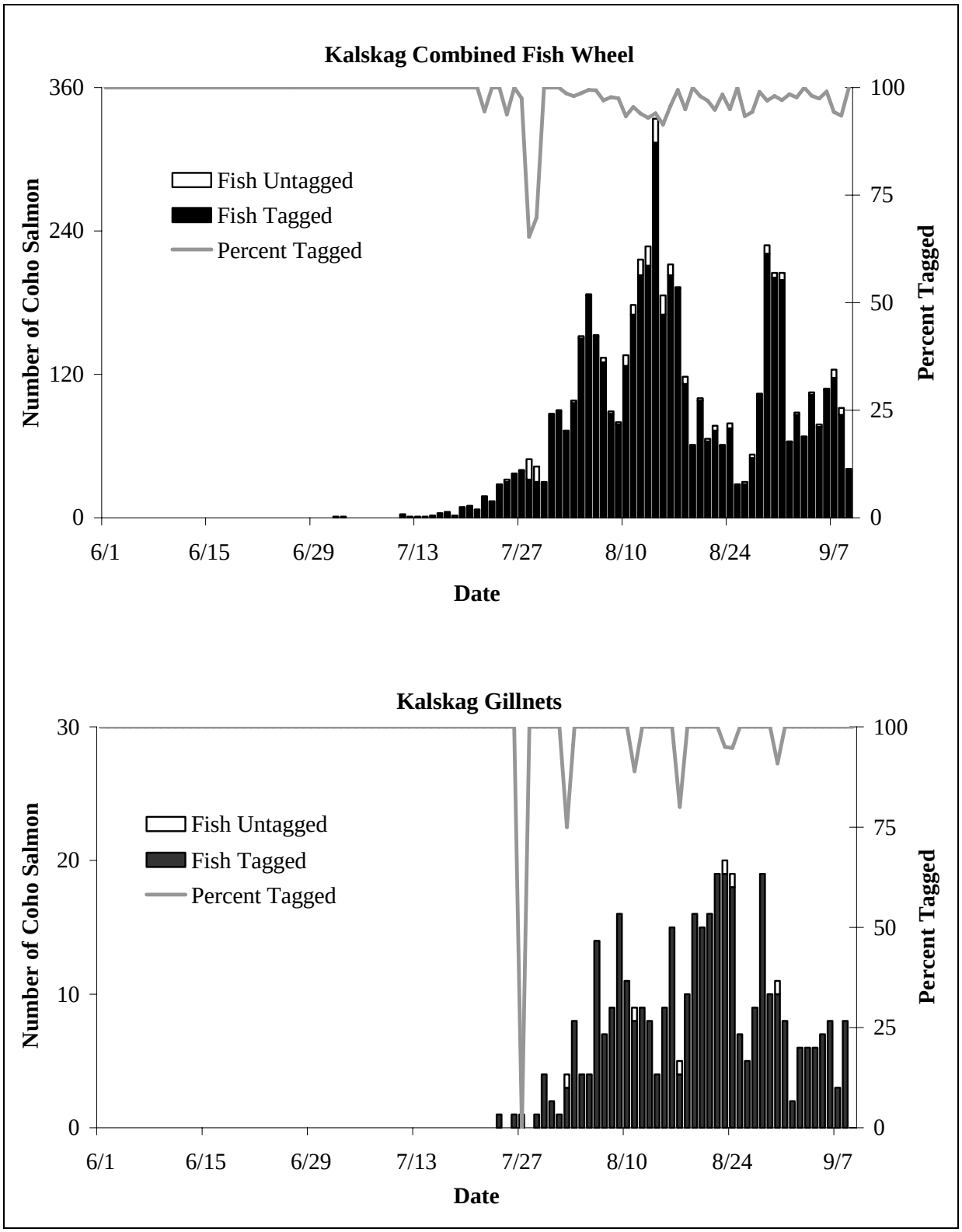


Figure 10.–Number of coho salmon tagged by date compared to the percent of coho salmon tagged at the Kalskag site on the Kuskokwim River, 2005.

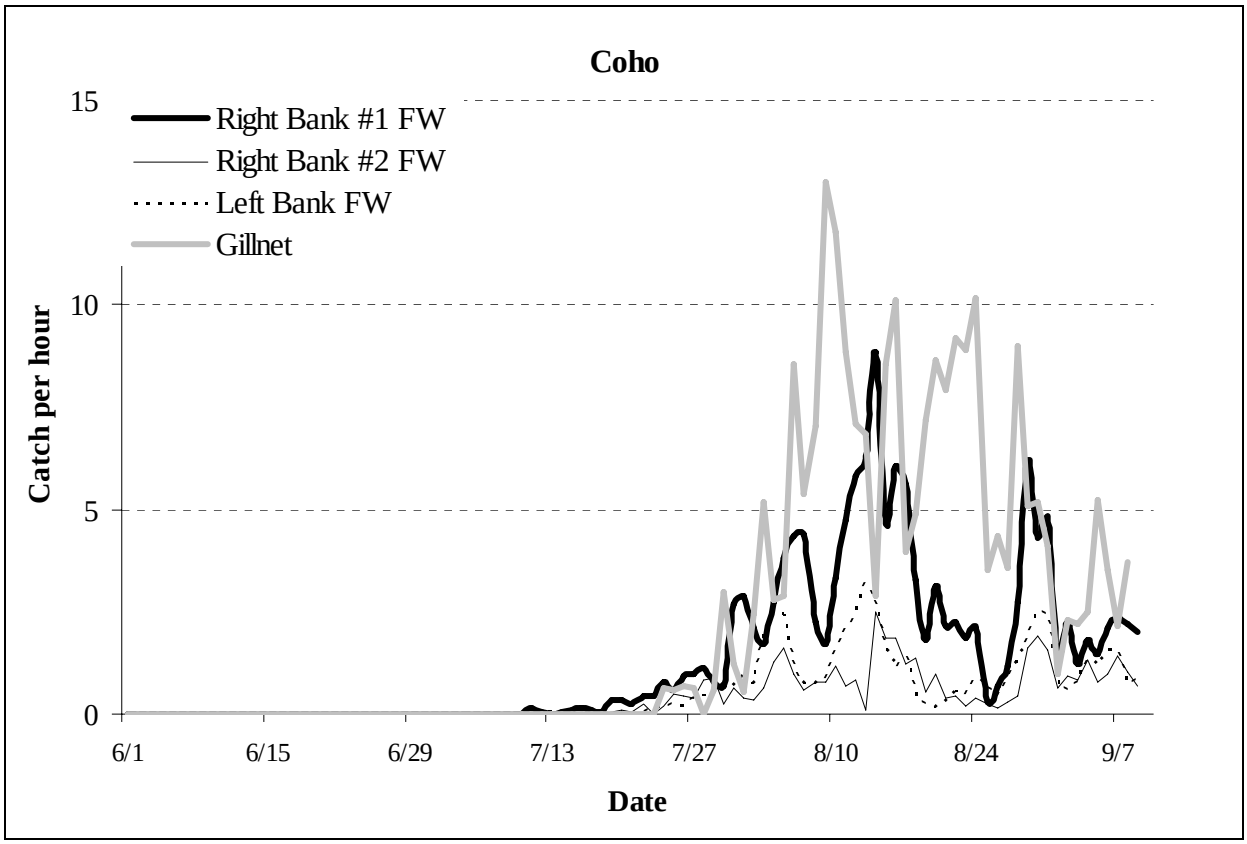
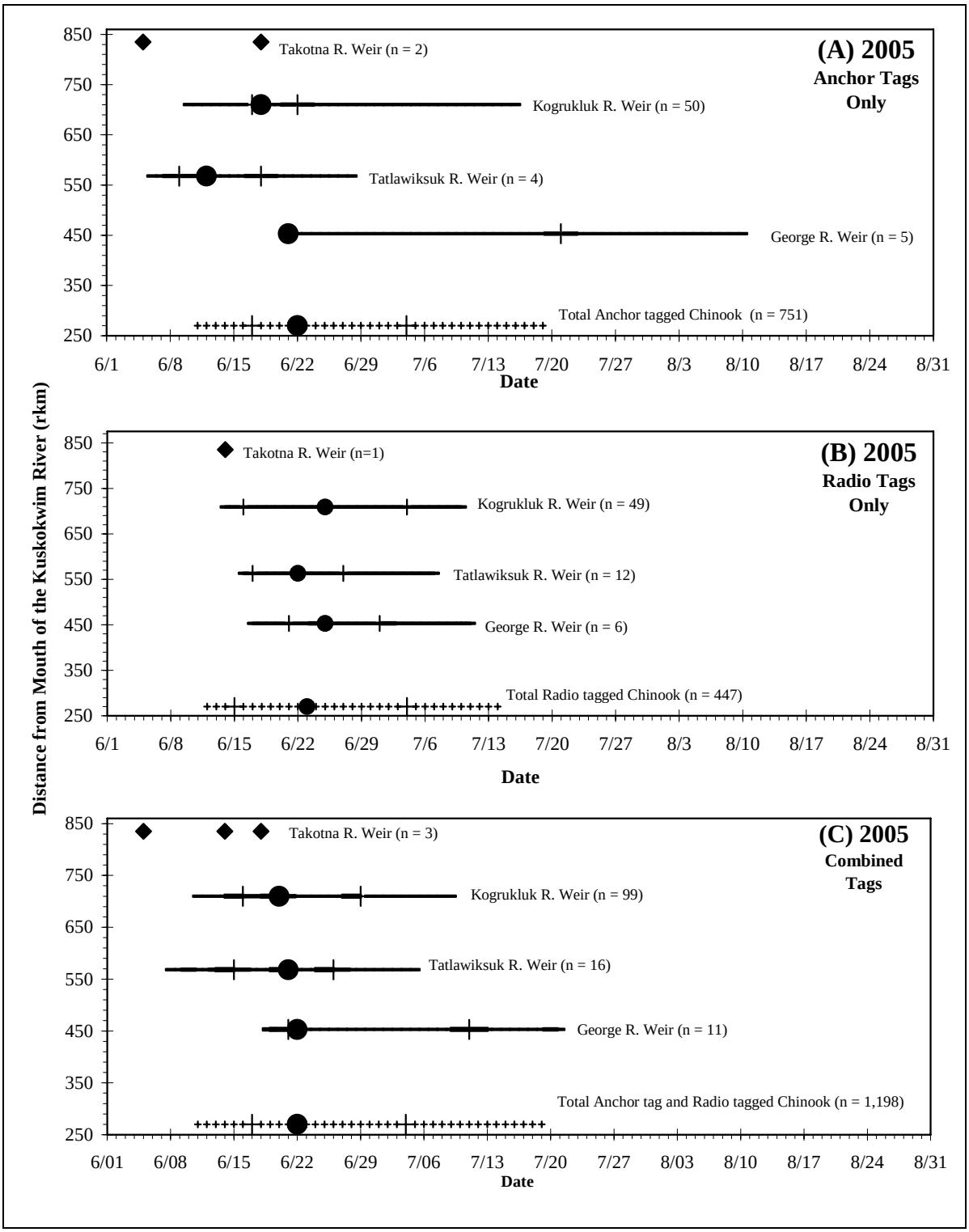
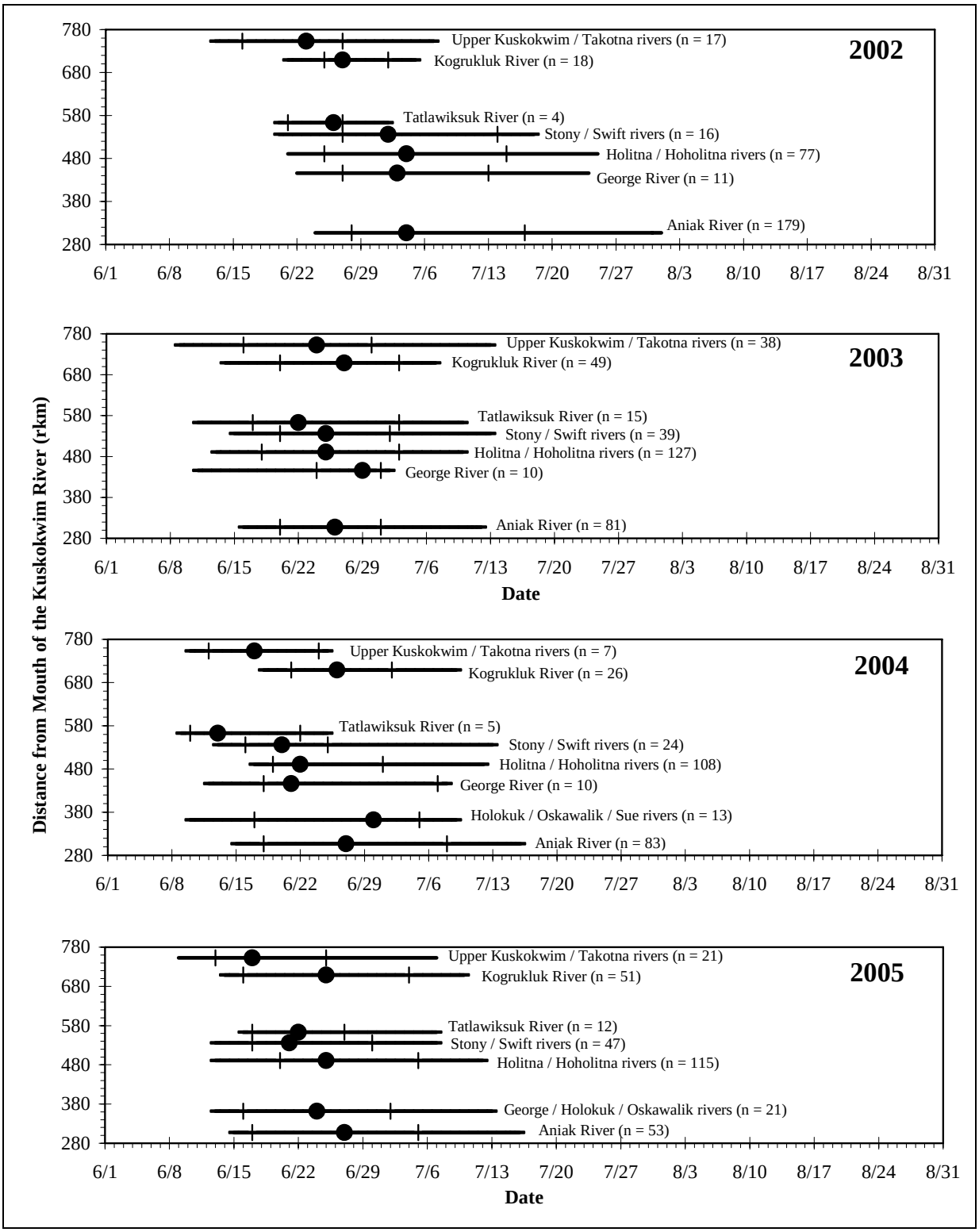


Figure 11.–Catch per hour of coho salmon from fish wheels (FW) and drift gillnets on the Kuskokwim River, 2005.



Note: Solid lines represent the central 80%, cross-bars represent the central 50%, and circles represent the median passage date for each stock.

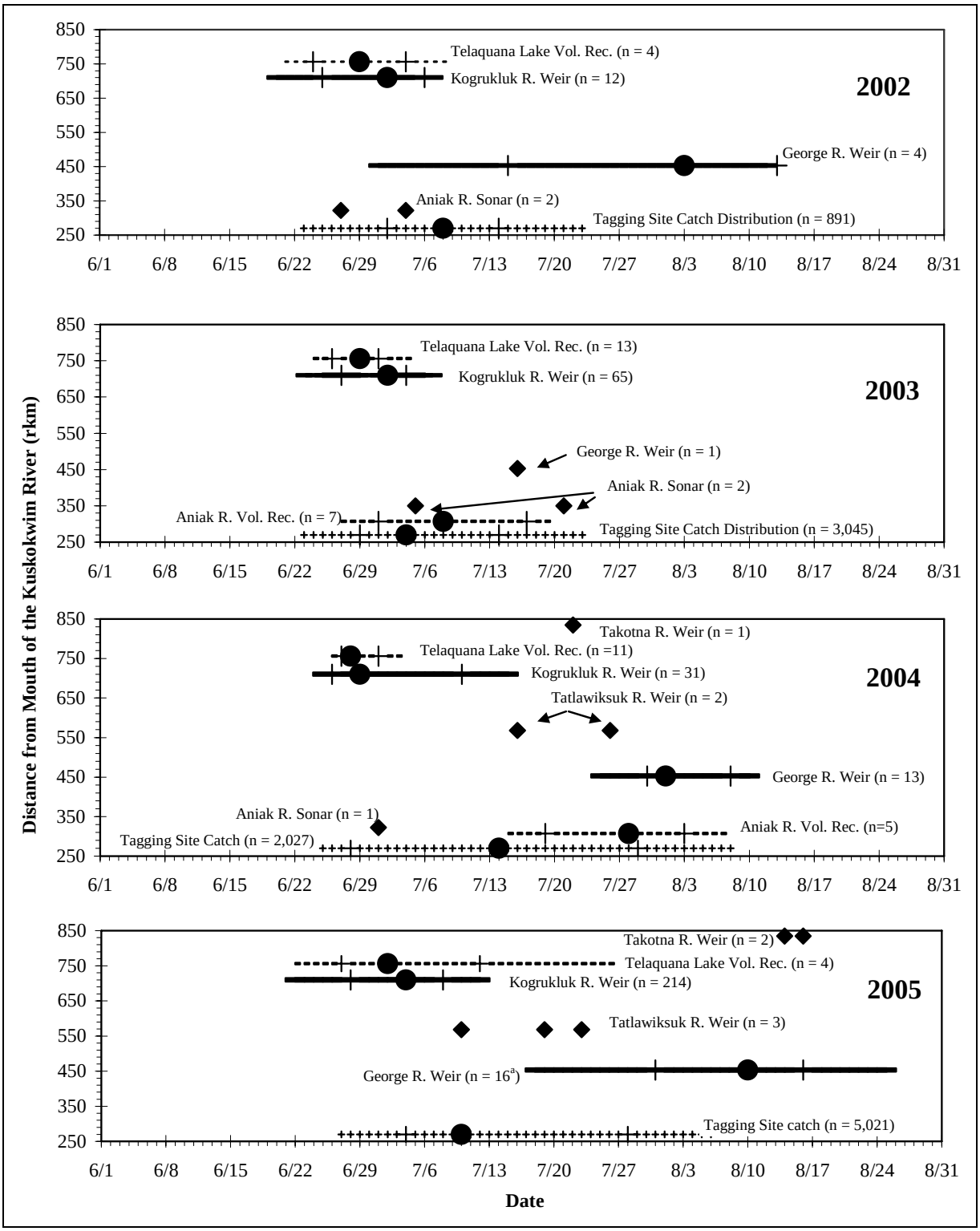
Figure 12.–Dates when Chinook salmon stocks monitored at tributary escapement projects pass through the Kalskag tagging site (rkm 271), based on Chinook tagged with (a) anchor tags only, (b) radio tags only, and (c) all tags combined.



Source: Stuby ***In prep.***

***Note*: Solid lines represent the central 80%, cross-bars represent the central 50%, and circles represent the median passage date for each stock.**

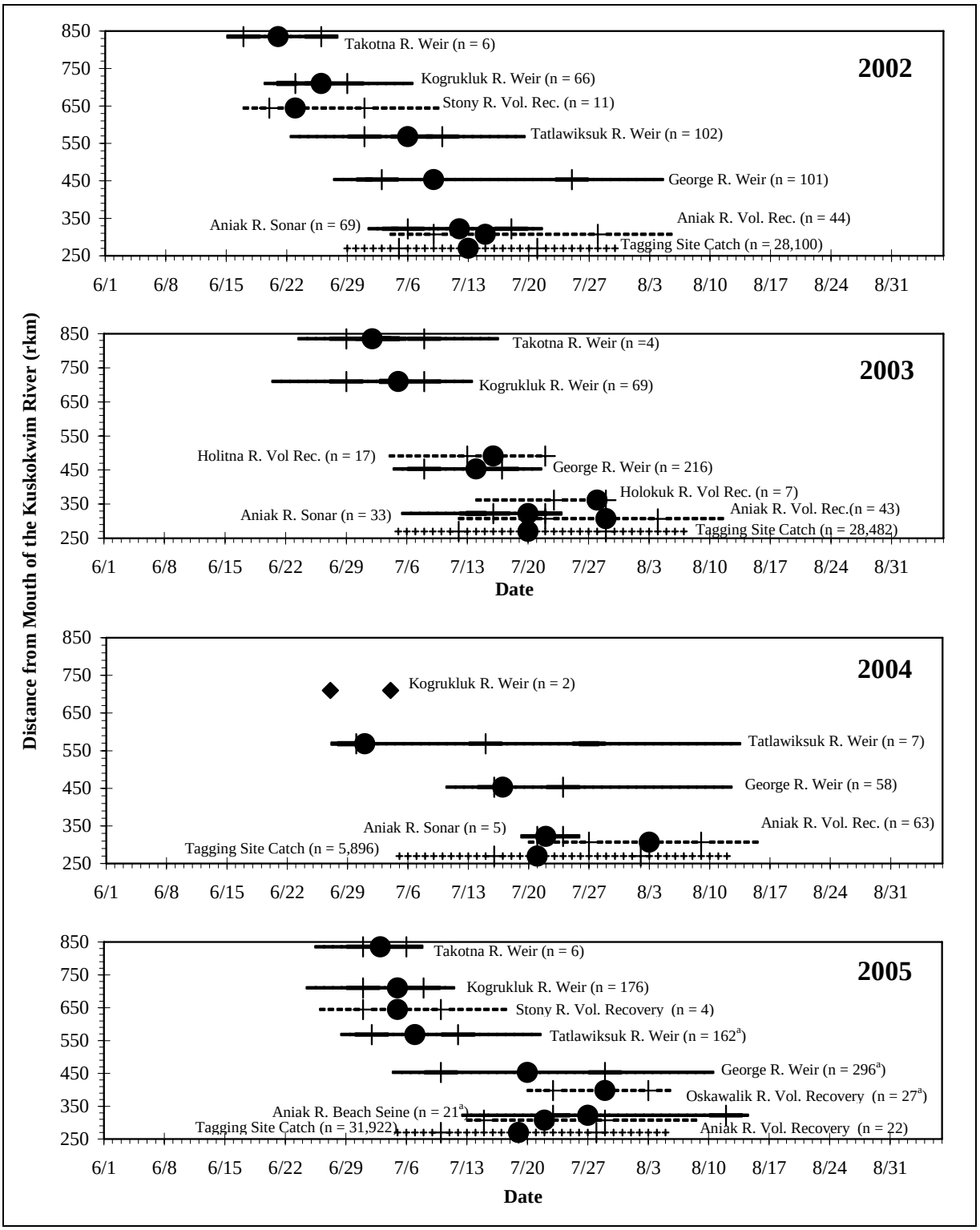
Figure 13.–Dates when individual Chinook salmon stocks pass through the Kalskag tagging site (rkm 271) based on radiotelemetry.



Note: Solid lines represent the central 80%, cross-bars represent the central 50%, and circles represent the median passage date for each stock.

[a] Weighted (includes recoveries of fish weighted more than one).

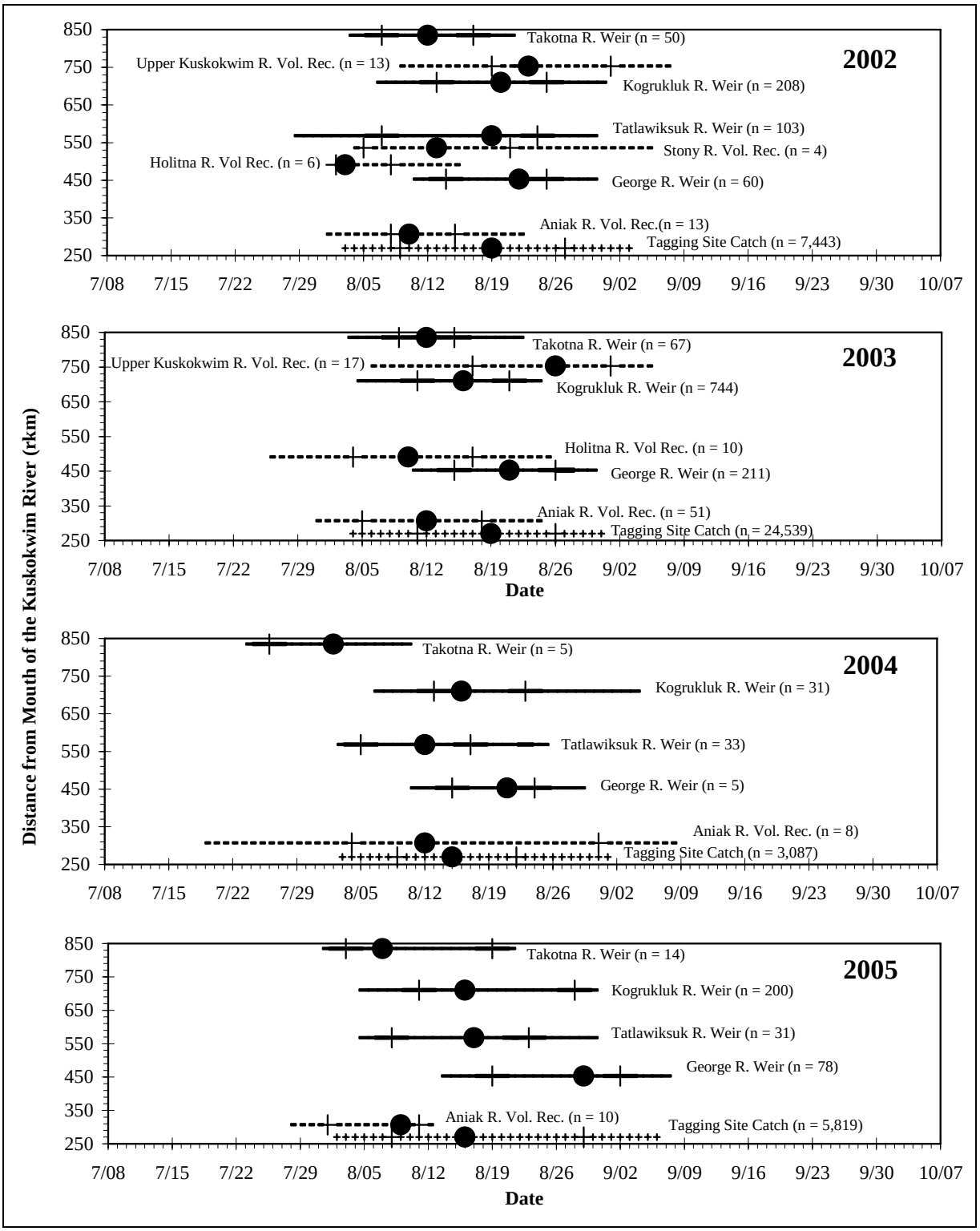
Figure 14.–Dates when individual sockeye salmon stocks pass through the Kalskag tagging site (rkm 271) based on sockeye salmon tagged with anchor tags



Note: Solid lines represent the central 80%, cross-bars represent the central 50%, and circles represent the median passage date for each stock.

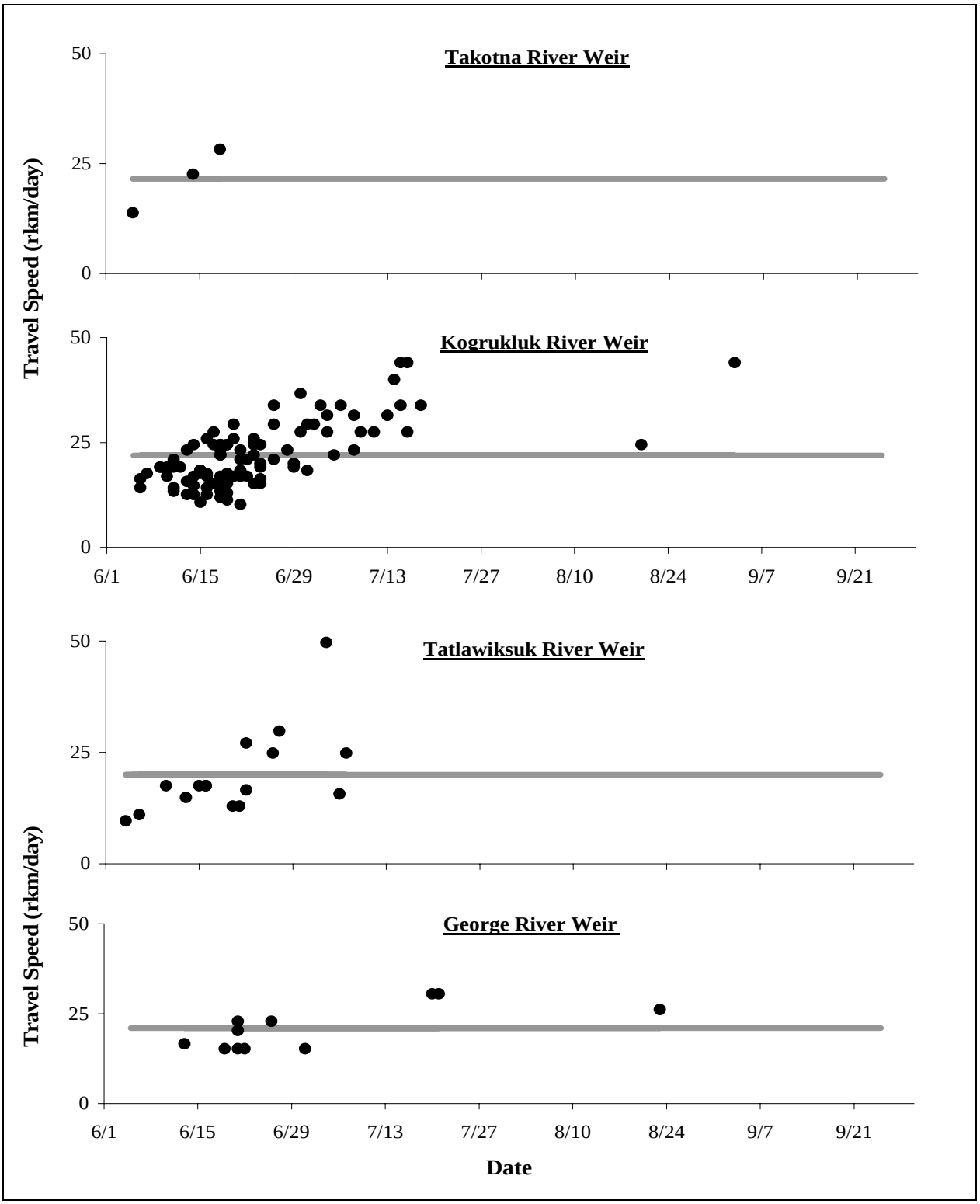
[a] Weighted (includes recoveries of fish weighted more than one).

Figure 15.–Dates when individual chum salmon stocks pass through the Kalskag tagging site (rkm 271) based on chum salmon tagged with anchor tags



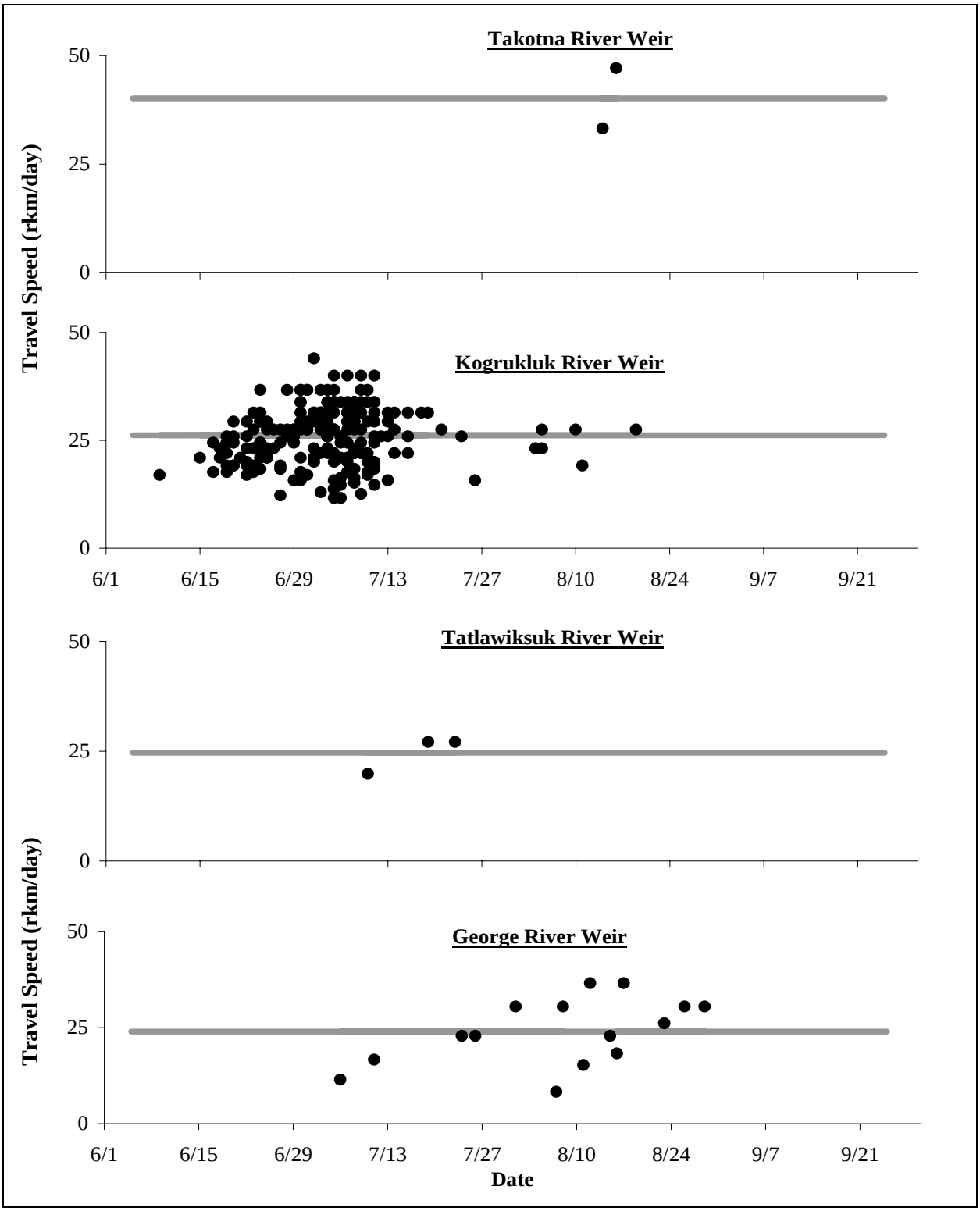
Note: Solid lines represent the central 80%, cross-bars represent the central 50%, and circles represent the median passage date for each stock.

Figure 16.–Dates when individual coho salmon stocks pass through the Kalskag tagging site (rkm 271) based on coho salmon tagged with anchor tags.



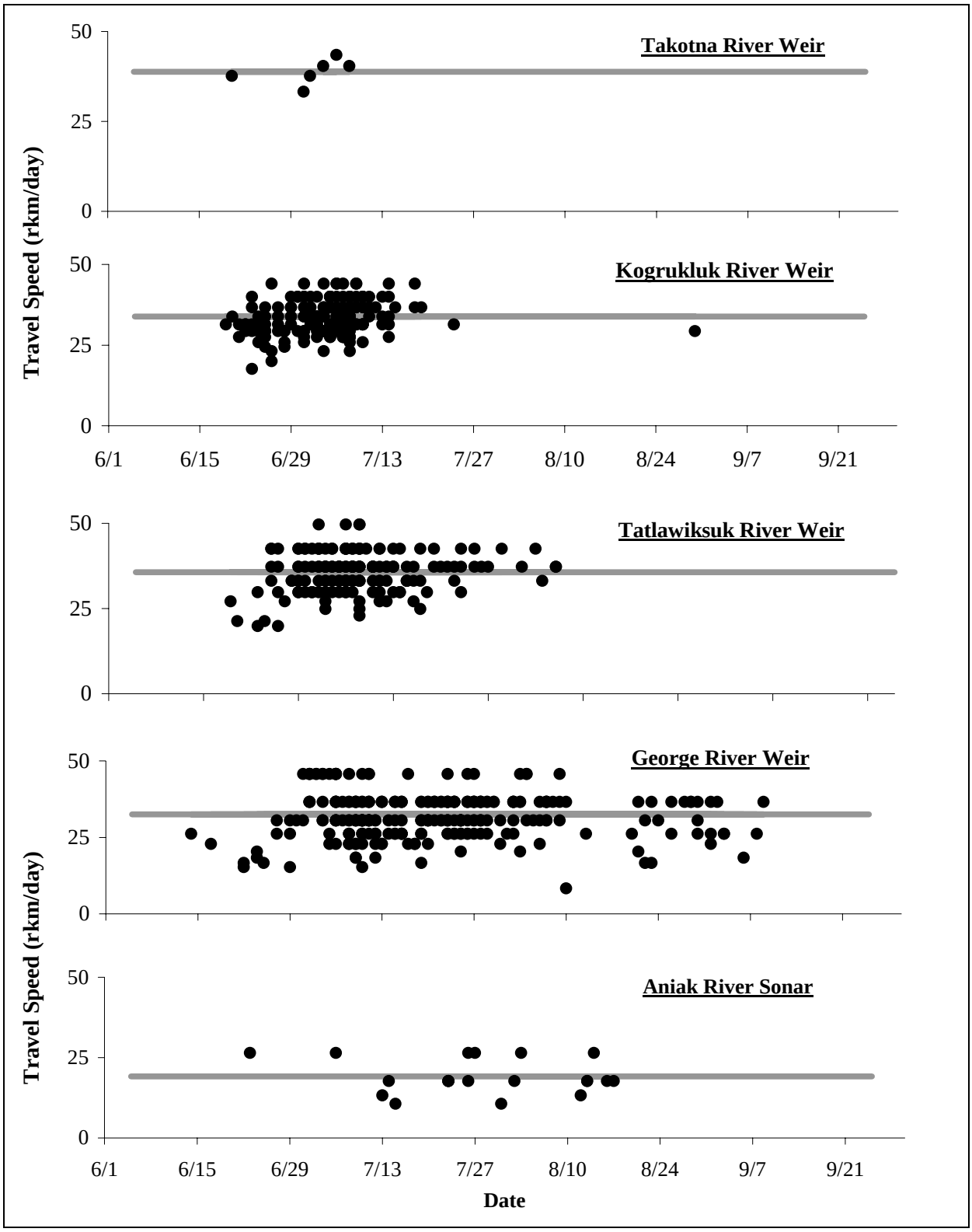
***Note*: The line represents the mean travel speed.**

Figure 17.–Travel speed (rkm/day) of both anchor- and radio-tagged Chinook salmon from the Kalskag site to the George, Tatlawiksuk, Kogrukluk, and Takotna River weirs on the Kuskokwim River, 2005.



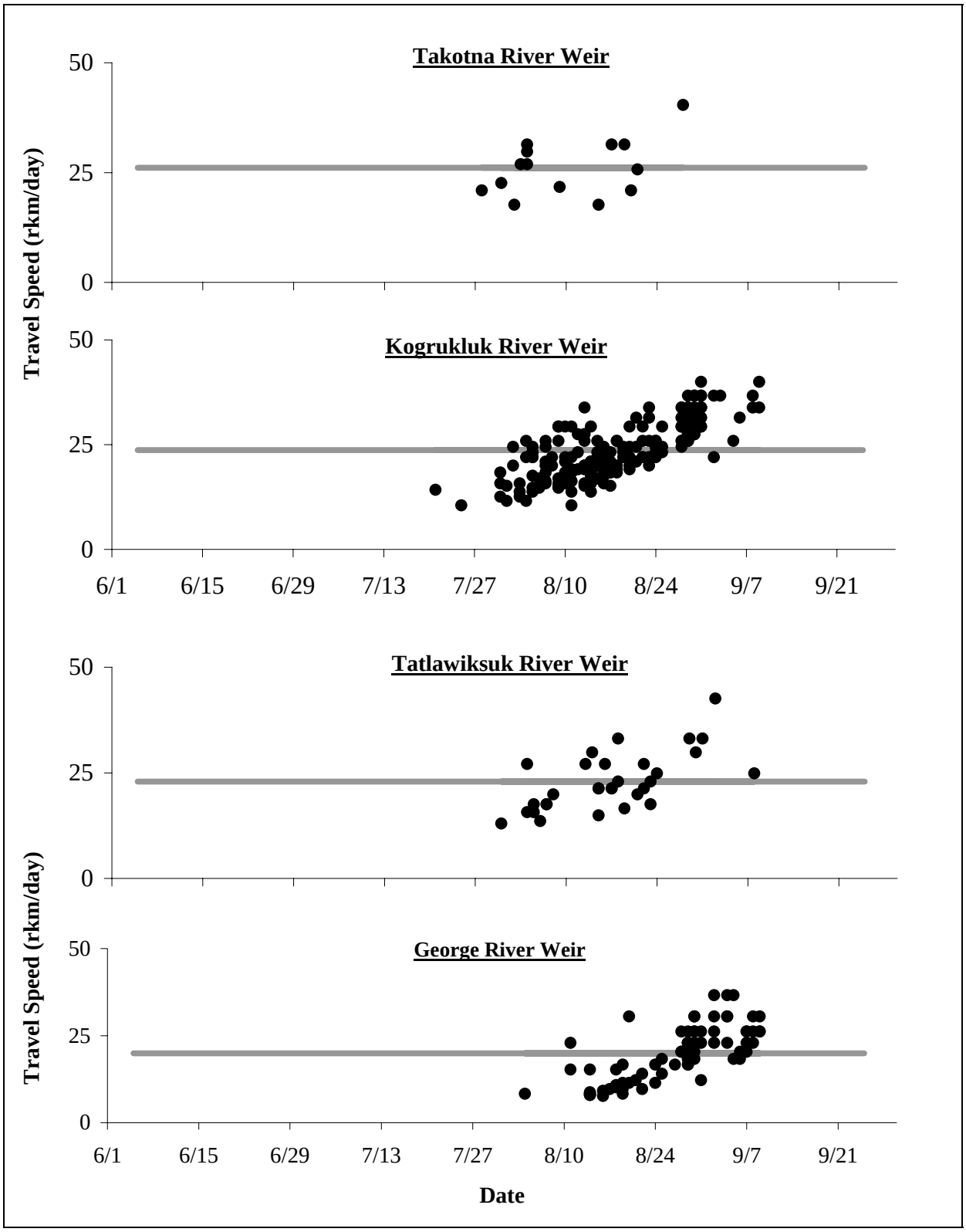
***Note*: The line represents the mean travel speed.**

Figure 18.–Travel speed (rkm/day) of anchor-tagged sockeye salmon from the Kalskag site to the George, Tatlawiksuk, Kogrukluk, and Takotna River weirs on the Kuskokwim River, 2005.



Note: The line represents the mean travel speed.

Figure 19.–Travel speed (rkm/day) of anchor-tagged chum salmon from the Kalskag site to the George, Tatlawiksuk, Kogrukluk, and Takotna River weirs on the Kuskokwim River, 2005.



***Note*: The line represents the mean travel speed.**

Figure 20.–Travel speed (rkm/day) of anchor-tagged coho salmon from the Kalskag site to the George, Tatlawiksuk, Kogrukluk, and Takotna River weirs on the Kuskokwim River, 2005.

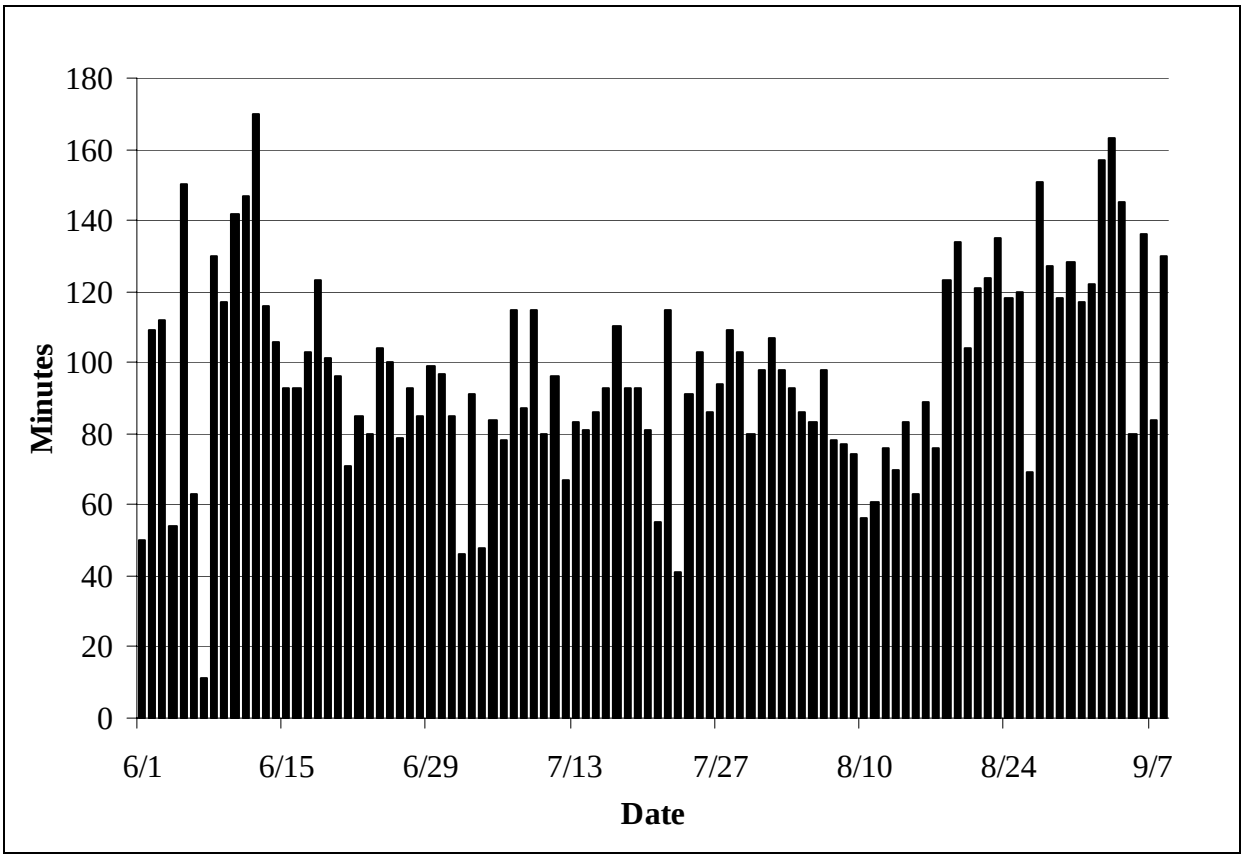


Figure 21.–Daily effort in minutes for drift gillnetting on the Kuskokwim River, 2005.

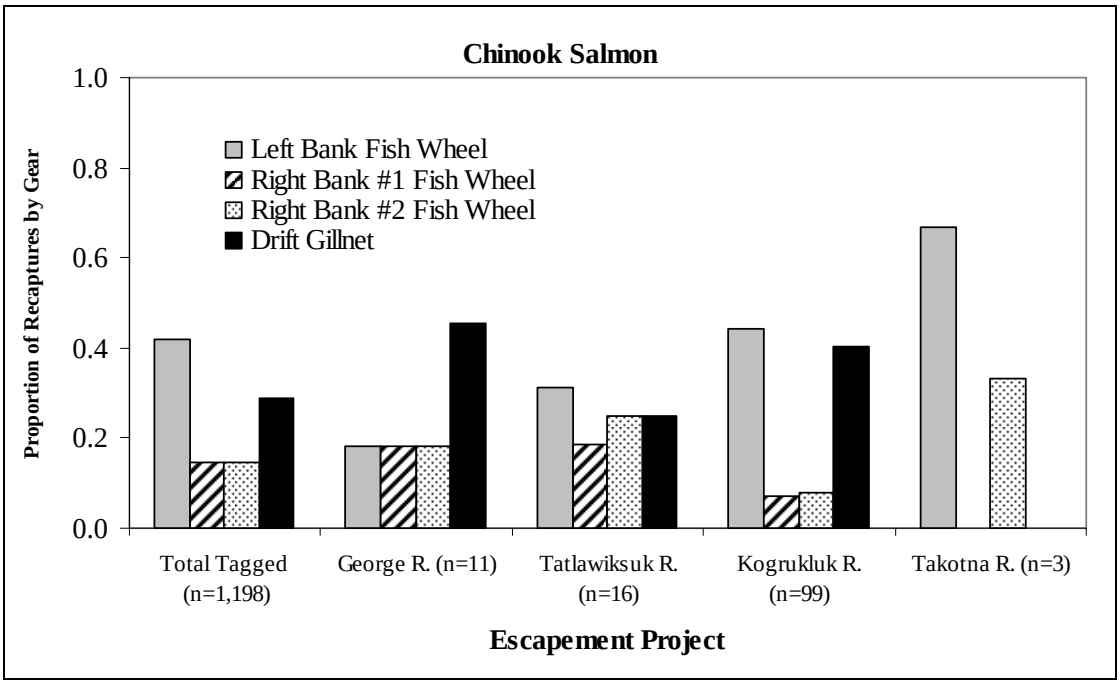


Figure 22.–Proportion of recaptures of Chinook salmon tagged at the Kalskag site by gear type and recovered at upstream escapement projects on the Kuskokwim River, 2005.

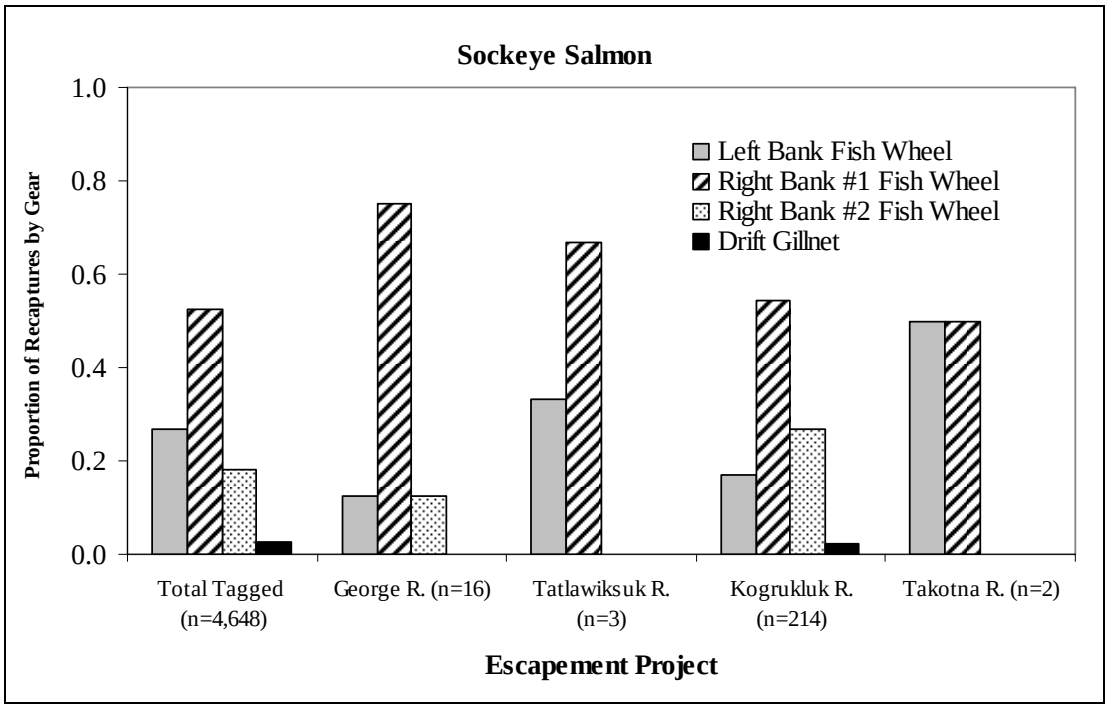


Figure 23.–Proportion of recaptures of sockeye salmon tagged at the Kalskag site by gear type and recovered at upstream escapement projects on the Kuskokwim River, 2005.

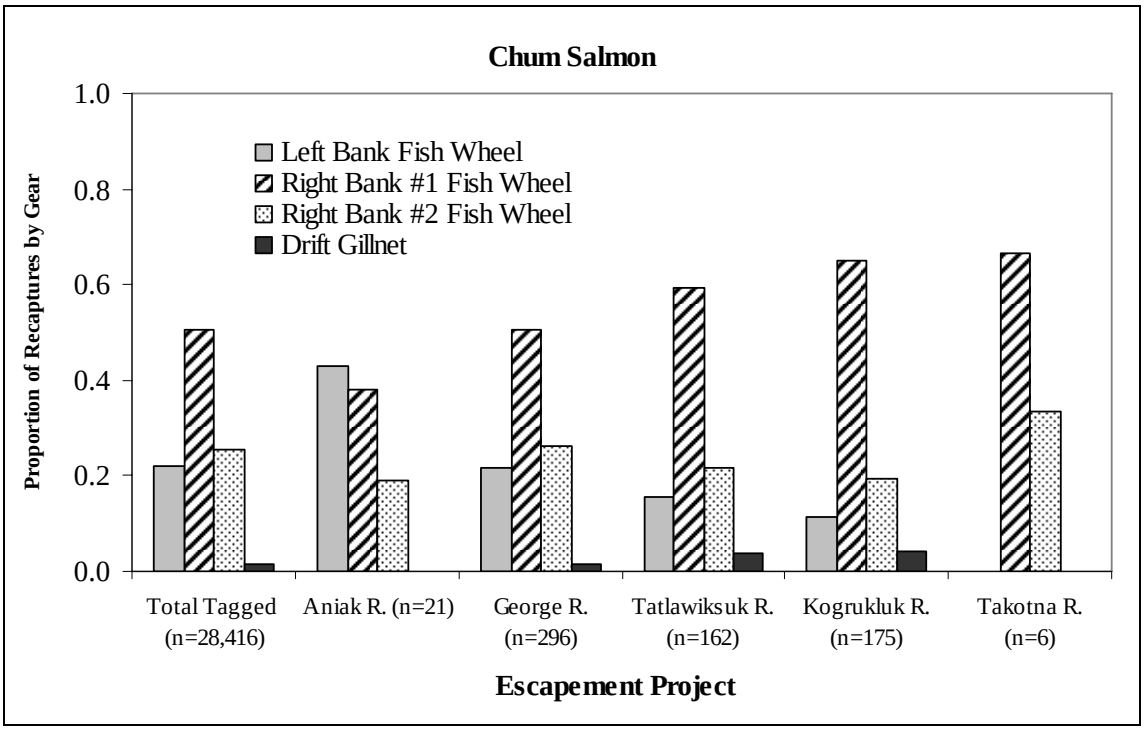


Figure 24.–Proportion of recaptures of chum salmon tagged at the Kalskag site by gear type and recovered at upstream escapement projects on the Kuskokwim River, 2005.

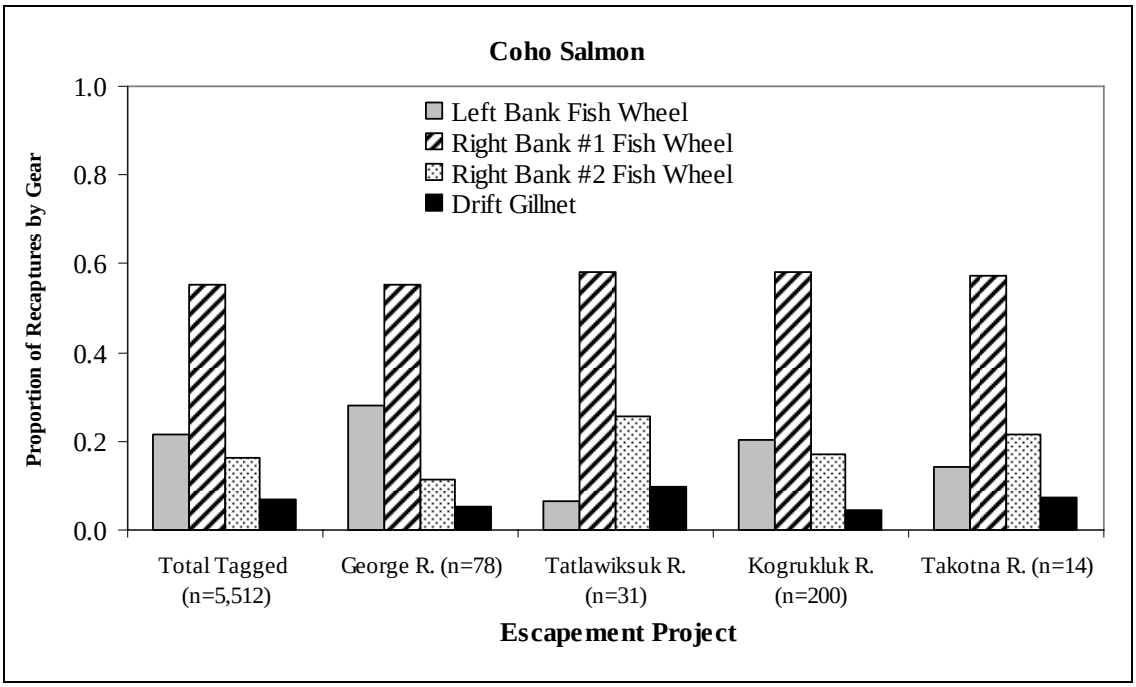


Figure 25.–Proportion of recaptures of coho salmon tagged at the Kalskag site by gear type and recovered at upstream escapement projects on the Kuskokwim River, 2005.

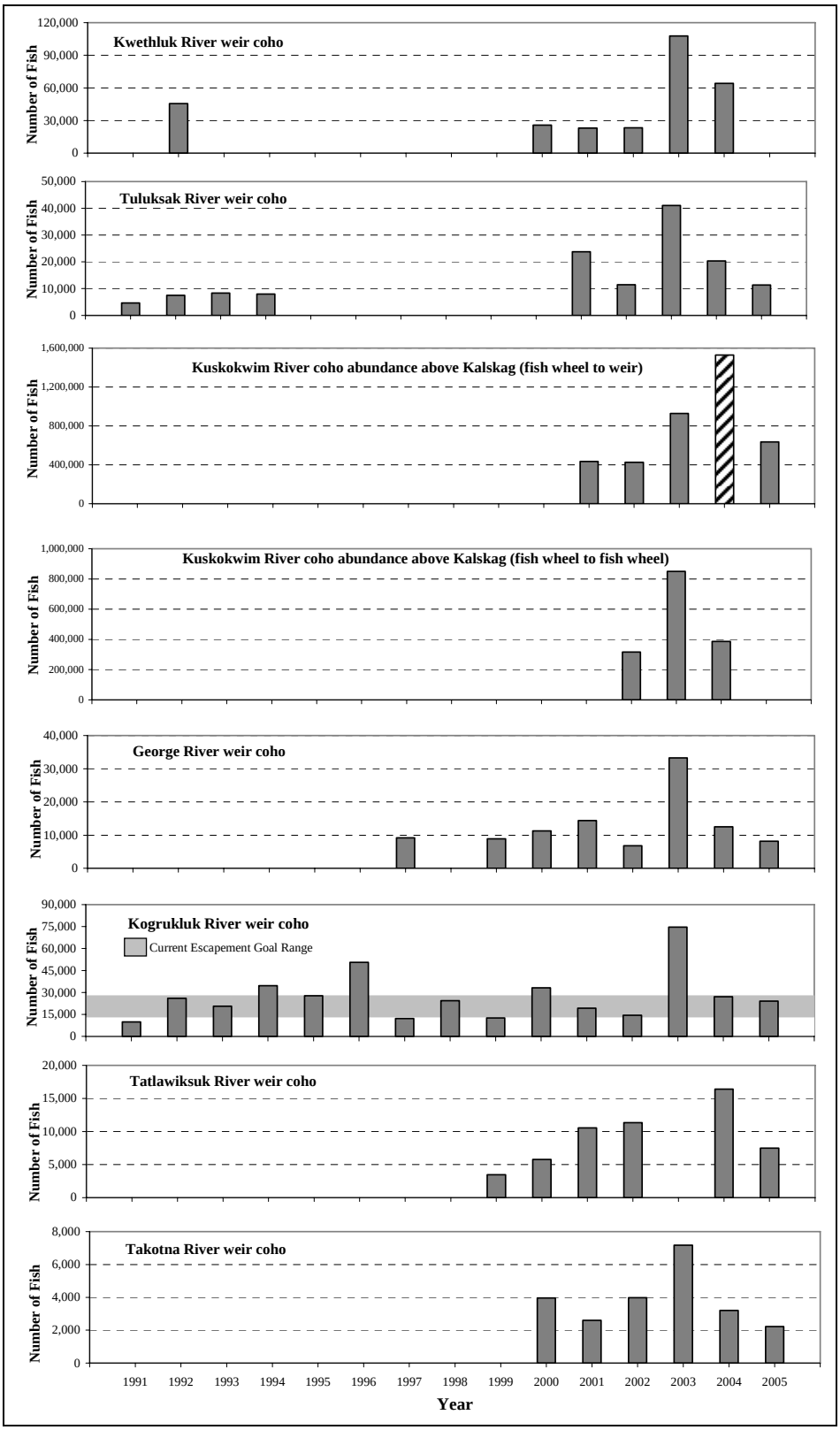


Figure 26.–Kuskokwim River tributary coho salmon escapement compared to two types of coho abundance estimates conducted on the mainstem Kuskokwim River, 2001–2005.

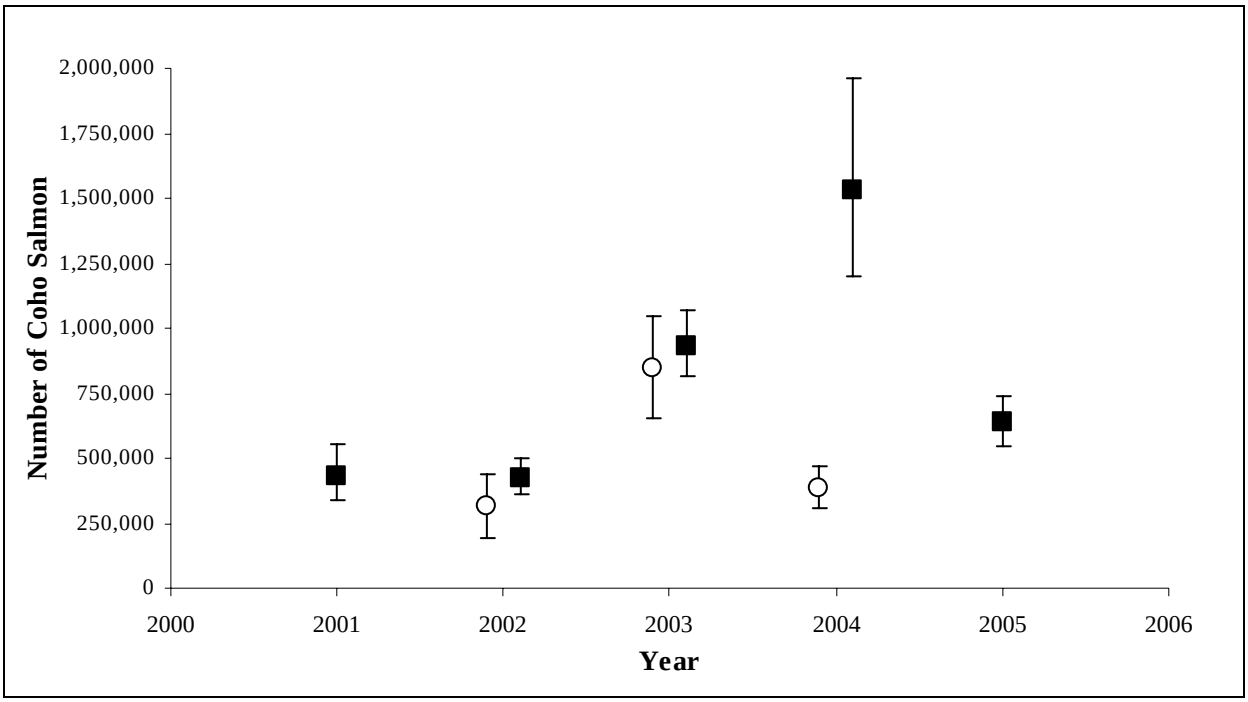


Figure 27.–A comparison by year of coho abundance estimates using wheel-to-weir or wheel-to-wheel data sets with their respective 95% confidence intervals.

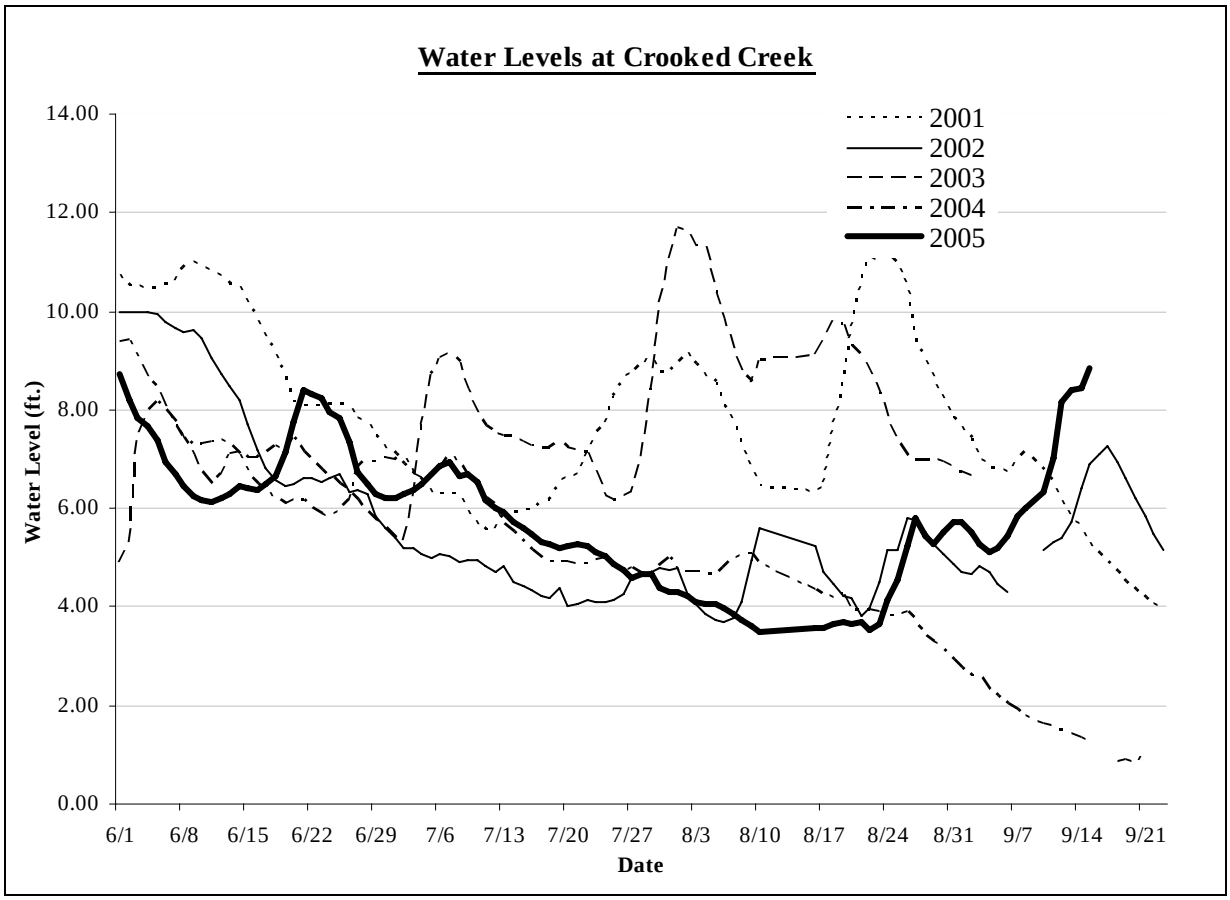


Figure 28.–Water levels at the Crooked Creek gauging station, on the mainstem Kuskokwim River, 2001–2005.

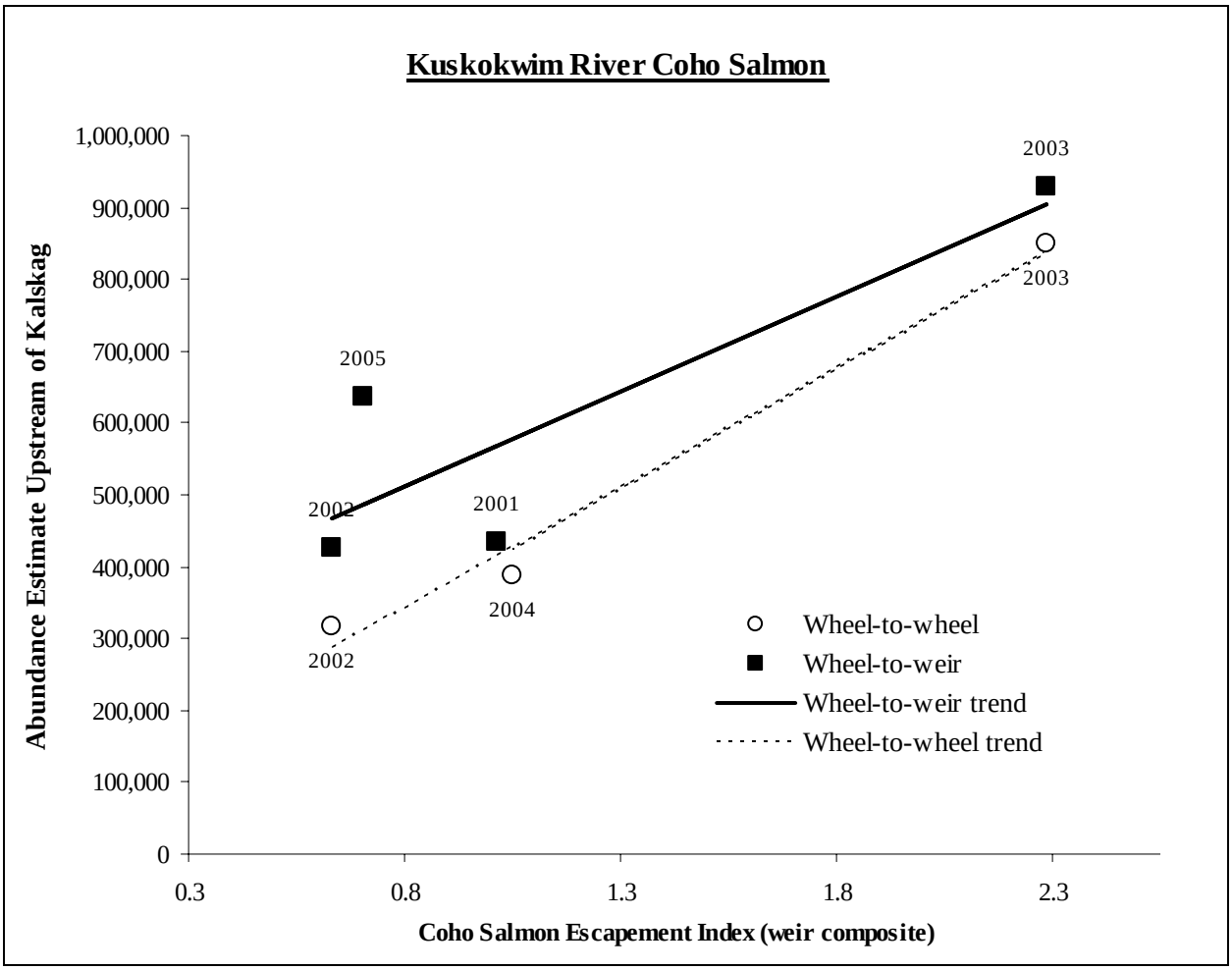


Figure 29.–The linear relationship between coho salmon abundance estimates (from wheel-to-wheel or wheel-to-weir data sets) to the median weir index by year.

APPENDIX A

Appendix A1.–Daily summary of tagged, untagged, and recaptured Chinook salmon at the Kalskag site on the Kuskokwim River, 2005.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
6/01	0	1	0	0	0	0	1	0	0	2	0.2
6/02	1	1	1	0	0	0	0	0	0	3	0.4
6/03	0	2	4	0	0	0	2	0	0	8	1.1
6/04	1	0	3	0	0	0	0	0	0	4	1.4
6/05	2	2	4	0	0	1	0	0	0	9	2.1
6/06	1	5	10	0	0	0	3	0	0	19	3.7
6/07	0	8	3	0	0	0	2	0	0	13	4.7
6/08	0	4	1	0	0	0	7	0	0	12	5.7
6/09	0	7	2	0	0	0	7	0	0	16	7.0
6/10	0	6	1	0	0	0	7	0	0	14	8.2
6/11	0	19	0	0	0	0	3	1	0	23	10.1
6/12	1	14	1	0	0	0	9	0	0	25	12.1
6/13	1	13	0	0	0	0	9	0	1	24	14.1
6/14	0	13	1	0	1	0	6	0	0	21	15.8
6/15	0	27	2	0	0	0	14	0	0	43	19.3
6/16	1	23	4	0	1	0	12	0	0	41	22.7
6/17	1	25	3	0	0	0	12	0	0	41	26.0
6/18	0	35	6	0	0	0	9	0	0	50	30.1
6/19	2	51	11	0	0	0	13	0	0	77	36.4
6/20	17	34	18	0	1	0	15	0	0	85	43.4
6/21	9	30	18	0	0	0	13	0	0	70	49.1
6/22	2	19	7	0	1	0	10	0	0	39	52.3
6/23	4	5	6	0	0	0	16	0	0	31	54.8
6/24	7	14	2	0	0	0	23	0	0	46	58.6
6/25	2	6	9	0	0	0	8	0	0	25	60.6
6/26	3	1	1	0	0	1	18	0	1	25	62.7
6/27	0	3	1	0	0	0	7	0	0	11	63.6
6/28	8	7	0	0	0	0	7	0	0	22	65.4
6/29	2	0	2	0	0	0	8	0	0	12	66.4
6/30	1	5	4	0	0	1	9	0	1	21	68.1
7/01	5	8	1	0	0	0	10	0	0	24	70.0
7/02	6	14	2	0	0	0	2	0	0	24	72.0
7/03	4	10	5	0	0	0	10	0	1	30	74.5
7/04	3	9	4	0	0	0	11	0	0	27	76.7
7/05	3	9	1	0	0	0	8	0	0	21	78.4
7/06	3	1	1	0	0	0	11	0	0	16	79.7
7/07	4	2	2	0	0	0	11	0	0	19	81.3
7/08	0	6	2	0	0	0	7	0	0	15	82.5
7/09	3	1	5	0	0	0	0	0	0	9	83.2
7/10	2	3	5	2	0	0	1	0	1	14	84.4

-continued-

Appendix A1.–Page 2 of 3.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
7/11	4	4	2	0	0	1	6	0	0	17	85.8
7/12	3	3	0	0	0	0	1	0	0	7	86.3
7/13	2	3	0	0	0	0	7	0	0	12	87.3
7/14	4	1	0	0	0	0	2	0	1	8	88.0
7/15	1	1	1	0	0	0	3	0	0	6	88.5
7/16	2	3	2	0	0	0	0	0	0	7	89.0
7/17	1	2	2	0	0	0	1	0	0	6	89.5
7/18	2	0	1	0	0	0	1	0	0	4	89.9
7/19	1	0	0	0	0	0	0	0	0	1	89.9
7/20	2	1	0	0	0	0	1	0	0	4	90.3
7/21	1	2	0	0	0	0	0	0	0	3	90.5
7/22	3	2	0	0	0	0	0	0	0	5	90.9
7/23	0	0	0	0	0	0	0	0	1	1	91.0
7/24	2	2	1	0	0	2	0	0	0	7	91.6
7/25	1	1	0	0	0	0	1	0	0	3	91.8
7/26	1	0	0	0	0	0	0	0	0	1	91.9
7/27	1	0	1	0	0	0	0	0	0	2	92.1
7/28	1	2	0	0	0	0	0	0	0	3	92.3
7/29	6	0	2	0	0	0	0	0	0	8	93.0
7/30	1	2	1	0	0	0	0	0	0	4	93.3
7/31	2	1	0	0	0	0	0	0	0	3	93.5
8/01	3	1	1	0	0	0	0	0	1	6	94.0
8/02	0	2	1	0	0	0	0	0	0	3	94.3
8/03	0	5	0	0	0	0	0	0	0	5	94.7
8/04	4	2	0	0	0	0	1	0	0	7	95.3
8/05	4	2	0	0	0	0	1	0	0	7	95.8
8/06	3	1	1	0	0	0	0	0	0	5	96.2
8/07	1	2	0	0	0	0	0	0	0	3	96.5
8/08	2	1	0	0	0	0	0	0	0	3	96.7
8/09	2	0	0	0	0	0	0	0	0	2	96.9
8/10	0	1	0	0	0	0	0	0	0	1	97.0
8/11	2	0	0	0	0	0	0	0	1	3	97.2
8/12	2	1	0	0	0	0	0	0	0	3	97.5
8/13	0	2	0	0	0	0	0	0	0	2	97.6
8/14	2	0	0	0	0	0	0	0	0	2	97.8
8/15	0	0	0	0	0	0	0	0	0	0	97.8
8/16	1	1	0	0	0	0	0	0	0	2	98.0
8/17	0	0	2	0	0	0	0	0	1	3	98.2
8/18	0	0	0	0	0	0	0	0	0	0	98.2
8/19	0	0	0	0	0	0	0	0	0	0	98.2
8/20	0	2	0	0	0	0	0	0	0	2	98.4
8/21	0	0	2	0	0	0	0	0	0	2	98.5

-continued-

Appendix A1.–Page 3 of 3.

Date	Right #1 Bank Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
8/22	0	1	0	0	0	0	0	0	0	1	98.6
8/23	0	0	1	0	0	0	0	0	0	1	98.7
8/24	1	0	0	0	0	0	0	0	0	1	98.8
8/25	0	1	0	0	0	0	0	0	0	1	98.9
8/26	0	0	0	0	0	0	0	0	0	0	98.9
8/27	0	0	0	0	0	0	0	0	0	0	98.9
8/28	0	0	0	0	0	0	0	0	0	0	98.9
8/29	0	2	0	0	0	0	0	0	0	2	99.0
8/30	0	1	1	0	0	0	0	0	0	2	99.2
8/31	0	0	0	0	0	0	0	0	0	0	99.2
9/01	2	1	0	0	0	0	0	0	0	3	99.4
9/02	0	0	0	0	0	0	0	0	0	0	99.4
9/03	2	0	0	0	0	0	0	0	0	2	99.6
9/04	1	0	0	0	0	0	0	0	0	1	99.7
9/05	1	0	0	0	0	0	0	0	1	2	99.8
9/06	0	0	1	0	0	0	0	0	0	1	99.9
9/07	0	0	0	0	0	0	0	0	0	0	99.9
9/08	0	0	0	0	0	0	0	0	0	0	99.9
9/09	0	1	0	0	0	0	0	0	0	1	100.0
Total	173	503	176	2	4	6	346	1	11	1,222	

Appendix A2.–Daily summary of tagged, untagged, and recaptured sockeye salmon at the Kalskag site on the Kuskokwim River, 2005.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
6/01	0	0	0	0	0	0	0	0	0	0	0.0
6/02	0	0	0	0	0	0	0	0	0	0	0.0
6/03	0	0	0	0	0	0	0	0	0	0	0.0
6/04	0	0	0	0	0	0	0	0	0	0	0.0
6/05	0	0	0	0	0	0	0	0	0	0	0.0
6/06	0	0	0	0	0	0	0	0	0	0	0.0
6/07	1	0	0	0	0	0	0	0	0	1	0.0
6/08	0	0	0	0	0	0	0	1	0	1	0.0
6/09	0	2	0	0	0	0	0	0	0	2	0.1
6/10	0	0	0	0	0	0	0	0	0	0	0.1
6/11	0	1	1	0	0	0	0	0	0	2	0.1
6/12	0	2	0	0	0	0	0	0	0	2	0.2
6/13	0	2	0	0	0	0	1	0	0	3	0.2
6/14	0	2	0	0	0	0	1	0	0	3	0.3
6/15	0	5	0	0	0	1	2	0	1	9	0.5
6/16	0	9	0	0	0	0	3	0	0	12	0.7
6/17	5	23	5	1	2	0	2	1	0	39	1.5
6/18	5	16	3	0	1	0	2	0	1	28	2.0
6/19	2	14	10	0	1	1	2	0	0	30	2.6
6/20	11	8	15	0	0	0	3	0	0	37	3.4
6/21	13	4	11	1	0	0	2	0	0	31	4.0
6/22	13	3	18	0	0	0	4	0	0	38	4.7
6/23	12	6	13	0	0	0	11	0	0	42	5.6
6/24	28	9	18	3	0	2	5	0	1	66	6.9
6/25	36	14	24	0	0	0	16	0	0	90	8.7
6/26	30	14	14	0	1	1	13	0	0	73	10.1
6/27	32	7	15	0	0	2	6	0	0	62	11.4
6/28	32	12	13	2	0	0	9	0	2	70	12.8
6/29	51	23	21	3	2	2	6	0	2	110	15.0
6/30	37	18	30	0	0	0	0	0	1	86	16.7
7/01	37	29	30	0	0	0	1	0	1	98	18.6
7/02	60	19	31	1	0	0	7	0	1	119	21.0
7/03	62	29	34	1	0	2	3	0	2	133	23.6
7/04	64	24	47	0	0	0	0	0	1	136	26.3
7/05	62	48	42	1	1	0	6	1	1	162	29.6
7/06	72	56	52	0	0	1	2	0	7	190	33.4
7/07	83	35	28	1	0	0	1	0	1	149	36.3
7/08	106	29	48	0	0	1	1	0	5	190	40.1
7/09	66	42	27	1	0	0	2	0	1	139	42.9
7/10	114	41	23	0	0	0	3	0	3	184	46.5

-continued-

Appendix A2.–Page 2 of 3.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
7/11	107	44	34	1	1	0	0	0	2	189	50.3
7/12	50	24	16	1	0	1	0	0	3	95	52.2
7/13	49	20	10	3	0	0	1	0	1	84	53.9
7/14	56	17	15	0	0	0	1	0	4	93	55.7
7/15	44	34	10	0	0	0	1	0	2	91	57.5
7/16	58	26	15	1	1	0	0	0	2	103	59.6
7/17	30	27	9	2	0	0	0	0	2	70	61.0
7/18	44	11	3	0	0	0	0	1	3	62	62.2
7/19	29	7	5	0	0	0	0	0	1	42	63.1
7/20	35	20	5	0	0	0	0	0	3	63	64.3
7/21	30	15	6	0	0	0	0	0	2	53	65.4
7/22	31	13	7	0	0	0	0	0	3	54	66.4
7/23	50	6	6	0	0	0	0	0	2	64	67.7
7/24	43	16	4	3	0	0	1	0	4	71	69.1
7/25	33	19	9	0	0	0	0	0	5	66	70.4
7/26	63	20	6	1	0	0	0	0	2	92	72.3
7/27	56	26	8	2	0	0	0	0	4	96	74.2
7/28	36	14	6	7	0	25	0	0	2	90	76.0
7/29	26	16	4	21	0	9	0	0	2	78	77.5
7/30	18	18	2	9	0	9	0	0	4	60	78.7
7/31	27	18	7	14	0	20	0	0	3	89	80.5
8/01	37	16	4	17	2	3	0	0	4	83	82.2
8/02	22	21	2	2	1	0	0	0	4	52	83.2
8/03	26	31	5	16	0	2	0	0	3	83	84.8
8/04	33	28	8	6	0	4	0	0	3	82	86.5
8/05	50	21	9	0	0	0	0	0	6	86	88.2
8/06	29	19	4	0	0	0	0	0	3	55	89.3
8/07	26	12	3	0	0	0	0	0	5	46	90.2
8/08	28	12	3	0	0	0	0	0		43	91.1
8/09	32	11	4	0	0	0	0	0	2	49	92.0
8/10	29	13	2	0	1	0	0	0	2	47	93.0
8/11	32	10	3	0	0	1	0	0	2	48	93.9
8/12	28	7	3	0	0	0	0	0	5	43	94.8
8/13	10	13	0	1	0	0	0	0	1	25	95.3
8/14	11	12	2	1	0	0	0	0		26	95.8
8/15	8	9	0	0	0	0	0	0	2	19	96.2
8/16	8	8	1	1	0	1	0	0	1	20	96.6
8/17	14	4	2	0	0	0	0	0	1	21	97.0
8/18	7	3	2	0	0	0	0	0	1	13	97.3
8/19	10	6	1	0	0	0	0	0		17	97.6
8/20	8	1	1	0	0	0	0	0	1	11	97.8
8/21	4	0	2	0	0	0	0	0		6	97.9

-continued-

Appendix A2.–Page 3 of 3.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
8/22	5	5	1	0	0	0	0	0		11	98.1
8/23	8	6	0	0	0	0	0	0	3	17	98.5
8/24	7	6	1	0	0	0	1	0	2	17	98.8
8/25	0	0	0	0	0	0	0	0		0	98.8
8/26	1	1	1	0	0	0	0	0		3	98.9
8/27	0	0	2	0	0	0	0	0		2	98.9
8/28	1	2	2	0	0	0	0	0		5	99.0
8/29	4	2	5	0	1	0	0	0		12	99.3
8/30	1	2	2	0	0	0	0	0		5	99.4
8/31	1	0	2	0	0	0	0	0		3	99.4
9/1	0	0	0	0	0	0	0	0	1	1	99.4
9/2	1	2	3	1	0	0	0	0		7	99.6
9/3	3	1	2	0	0	0	0	0		6	99.7
9/4	0	0	2	0	0	0	1	0	1	4	99.8
9/5	1	0	1	0	0	0	0	0		2	99.8
9/6	1	0	0	0	0	0	0	0		1	99.8
9/7	0	0	1	1	0	0	0	0		2	99.9
9/8	0	1	1	0	0	0	0	0		2	99.9
9/9	3	1	0	0	0	0	0	0		4	100.0
Total	2,438	1,243	847	126	15	88	120	4	140	5,021	

Appendix A3.–Daily summary of tagged, untagged, and recaptured chum salmon at the Kalskag site on the Kuskokwim River, 2005.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
6/01	0	0	0	0	0	0	0	0	0	0	0.0
6/02	1	0	0	0	0	0	0	0	0	1	0.0
6/03	0	0	0	0	0	0	0	0	0	0	0.0
6/04	0	0	0	0	0	0	0	0	0	0	0.0
6/05	0	0	0	0	0	0	0	0	0	0	0.0
6/06	0	0	0	0	0	0	0	0	0	0	0.0
6/07	0	1	0	0	0	0	0	0	0	1	0.0
6/08	0	0	0	0	0	0	0	0	0	0	0.0
6/09	0	0	0	0	0	0	0	0	0	0	0.0
6/10	0	0	0	0	0	0	2	0	0	2	0.0
6/11	0	0	0	1	0	0	0	0	0	1	0.0
6/12	0	0	0	0	0	0	0	0	0	0	0.0
6/13	0	1	0	0	0	0	1	0	0	2	0.0
6/14	0	0	0	0	0	0	1	0	0	1	0.0
6/15	0	1	0	0	0	0	2	0	0	3	0.0
6/16	0	1	0	0	0	0	2	0	0	3	0.0
6/17	1	3	1	0	0	0	9	0	0	14	0.1
6/18	3	2	0	0	0	0	8	0	0	13	0.1
6/19	1	0	3	0	1	0	2	0	0	7	0.2
6/20	26	1	2	0	0	0	1	0	0	30	0.2
6/21	32	3	2	0	0	0	6	0	1	44	0.4
6/22	46	1	1	4	0	0	6	0	1	59	0.6
6/23	74	6	16	3	1	0	10	0	1	111	0.9
6/24	55	8	6	1	1	1	15	0	5	92	1.2
6/25	63	19	9	2	0	0	13	0	4	110	1.5
6/26	49	17	2	1	0	1	11	1	1	83	1.8
6/27	52	5	2	1	0	0	11	0	4	75	2.0
6/28	100	5	2	4	0	0	13	0	3	127	2.4
6/29	142	16	28	6	0	1	5	0	5	203	3.1
6/30	60	26	24	2	1	0	7	0	4	124	3.5
7/01	147	23	41	2	1	2	11	0	5	232	4.2
7/02	175	50	66	1	0	0	13	0	6	311	5.2
7/03	229	84	85	0	1	2	17	0	5	423	6.5
7/04	360	141	176	1	6	2	4	1	18	709	8.7
7/05	368	132	189	5	5	0	68	24	22	813	11.3
7/06	492	246	206	10	5	4	11	1	22	997	14.4
7/07	561	190	201	13	2	4	2	0	26	999	17.5
7/08	627	251	334	17	1	6	12	0	22	1,270	21.5
7/09	435	138	236	15	2	7	18	0	37	888	24.3
7/10	548	121	362	6	2	8	21	0	38	1,106	27.7

-continued-

Appendix A3.–Page 2 of 3.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
7/12	408	101	142	19	1	6	13	0	30	720	33.3
7/13	498	71	166	18	2	3	7	0	23	788	35.7
7/14	371	110	274	11	5	4	8	0	42	825	38.3
7/15	430	117	226	10	4	6	8	0	39	840	40.9
7/16	460	170	164	4	2	7	12	0	42	861	43.6
7/17	357	126	225	8	2	4	6	0	39	767	46.0
7/18	378	92	197	8	2	2	10	0	29	718	48.3
7/19	444	109	155	11	3	3	1	0	48	774	50.7
7/20	449	120	227	5	2	5	7	0	60	875	53.5
7/21	361	132	205	14	2	9	2	0	68	793	55.9
7/22	471	183	228	23	8	11	7	1	50	982	59.0
7/23	562	191	258	27	9	13	0	0	53	1,113	62.5
7/24	438	184	262	22	6	4	4	0	71	991	65.6
7/25	293	123	196	12	5	10	3	0	30	672	67.7
7/26	435	206	163	17	8	1	0	0	34	864	70.4
7/27	336	176	156	4	3	6	0	0	43	724	72.7
7/28	290	246	168	90	5	262	1	0	43	1,105	76.1
7/29	189	145	112	149	3	113	2	1	20	734	78.4
7/30	106	154	53	68	1	92	5	1	22	502	80.0
7/31	106	150	50	57	2	95	1	0	18	479	81.5
8/01	171	137	70	72	7	63	0	0	21	541	83.2
8/02	113	106	125	18	1	9	6	0	17	395	84.4
8/03	97	181	89	98	12	86	3	0	14	580	86.3
8/04	235	199	220	51	4	47	5	0	25	786	88.7
8/05	307	191	168	2	5	6	1	0	40	720	91.0
8/06	199	121	106	3	3	2	8	0	51	493	92.5
8/07	129	79	65	5	2	0	6	0	20	306	93.5
8/08	85	54	53	6	4	0	2	1	20	225	94.2
8/09	110	64	45	7	1	1	5	0	15	248	95.0
8/10	63	57	36	3	4	6	0	0	19	188	95.6
8/11	59	92	11	4	3	1	5	1	16	192	96.2
8/12	61	90	13	3	9	1	4	0	7	188	96.7
8/13	30	71	1	4	3	0	0	0	3	112	97.1
8/14	24	41	12	1	1	1	0	0	2	82	97.4
8/15	25	31	11	2	3	0	2	0	5	79	97.6
8/16	12	23	9	0	0	1	1	0	4	50	97.8
8/17	18	19	5	0	0	0	1	0	2	45	97.9
8/18	13	12	10	0	0	0	0	0	1	36	98.0
8/19	11	6	8	0	1	0	0	0	2	28	98.1
8/20	22	8	9	2	0	0	1	0	1	43	98.2
8/21	12	10	3	3	0	0	0	0	2	30	98.3

-continued-

Appendix A3.–Page 3 of 3.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
8/22	14	17	8	0	0	0	2	0	1	42	98.5
8/23	15	23	8	3	1	0	1	0	1	52	98.6
8/24	20	21	2	2	1	0	0	0	4	50	98.8
8/25	2	11	2	0	0	0	3	1	2	21	98.8
8/26	3	18	4	0	0	0	2	0	0	27	98.9
8/27	3	4	7	1	0	0	1	0	0	16	99.0
8/28	17	17	17	1	0	1	1	0	6	60	99.2
8/29	17	11	20	2	0	0	0	0	4	54	99.3
8/30	14	11	17	1	0	0	0	0	5	48	99.5
8/31	18	8	14	1	0	0	0	0	5	46	99.6
9/01	7	1	5	1	0	0	0	0	0	14	99.7
9/02	9	3	4	0	0	0	0	0	0	16	99.7
9/03	4	8	5	0	0	0	0	0	1	18	99.8
9/04	6	7	2	1	0	0	0	0	0	16	99.8
9/05	5	1	3	0	0	0	0	0	2	11	99.9
9/06	1	1	2	0	0	0	0	0	0	4	99.9
9/07	5	10	3	2	0	0	0	0	2	22	99.9
9/08	5	1	2	0	0	0	0	0	2	10	100.0
9/09	2	2	2	0	0	0	0	0	0	6	100.0
Total	14,405	6,303	7,240	990	173	922	468	33	1,388	31,922	

Appendix A4.–Daily summary of tagged, untagged, and recaptured coho salmon at the Kalskag site on the Kuskokwim River, 2005.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
6/01	0	0	0	0	0	0	0	0	0	0	0.0
6/02	0	0	0	0	0	0	0	0	0	0	0.0
6/03	0	0	0	0	0	0	0	0	0	0	0.0
6/04	0	0	0	0	0	0	0	0	0	0	0.0
6/05	0	0	0	0	0	0	0	0	0	0	0.0
6/06	0	0	0	0	0	0	0	0	0	0	0.0
6/07	0	0	0	0	0	0	0	0	0	0	0.0
6/08	0	0	0	0	0	0	0	0	0	0	0.0
6/09	0	0	0	0	0	0	0	0	0	0	0.0
6/10	0	0	0	0	0	0	0	0	0	0	0.0
6/11	0	0	0	0	0	0	0	0	0	0	0.0
6/12	0	0	0	0	0	0	0	0	0	0	0.0
6/13	0	0	0	0	0	0	0	0	0	0	0.0
6/14	0	0	0	0	0	0	0	0	0	0	0.0
6/15	0	0	0	0	0	0	0	0	0	0	0.0
6/16	0	0	0	0	0	0	0	0	0	0	0.0
6/17	0	0	0	0	0	0	0	0	0	0	0.0
6/18	0	0	0	0	0	0	0	0	0	0	0.0
6/19	0	0	0	0	0	0	0	0	0	0	0.0
6/20	0	0	0	0	0	0	0	0	0	0	0.0
6/21	0	0	0	0	0	0	0	0	0	0	0.0
6/22	0	0	0	0	0	0	0	0	0	0	0.0
6/23	0	0	0	0	0	0	0	0	0	0	0.0
6/24	0	0	0	0	0	0	0	0	0	0	0.0
6/25	0	0	0	0	0	0	0	0	0	0	0.0
6/26	0	0	0	0	0	0	0	0	0	0	0.0
6/27	0	0	0	0	0	0	0	0	0	0	0.0
6/28	0	0	0	0	0	0	0	0	0	0	0.0
6/29	0	0	0	0	0	0	0	0	0	0	0.0
6/30	0	0	0	0	0	0	0	0	0	0	0.0
7/01	0	0	0	0	0	0	0	0	0	0	0.0
7/02	0	0	1	0	0	0	0	0	0	1	0.0
7/03	0	0	1	0	0	0	0	0	0	1	0.0
7/04	0	0	0	0	0	0	0	0	0	0	0.0
7/05	0	0	0	0	0	0	0	0	0	0	0.0
7/06	0	0	0	0	0	0	0	0	0	0	0.0
7/07	0	0	0	0	0	0	0	0	0	0	0.0
7/08	0	0	0	0	0	0	0	0	0	0	0.0
7/09	0	0	0	0	0	0	0	0	0	0	0.0
7/10	0	0	0	0	0	0	0	0	0	0	0.0
7/11	3	0	0	0	0	0	0	0	0	3	0.1
7/12	1	0	0	0	0	0	0	0	0	1	0.1
7/13	0	1	0	0	0	0	0	0	0	1	0.1
7/14	1	0	0	0	0	0	0	0	0	1	0.1
7/15	2	0	0	0	0	0	0	0	0	2	0.2

-continued-

Appendix A4.–Page 2 of 3.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
7/16	4	0	0	0	0	0	0	0	0	4	0.2
7/17	2	0	3	0	0	0	0	0	0	5	0.3
7/18	1	1	0	0	0	0	0	0	0	2	0.4
7/19	8	0	1	0	0	0	0	0	0	9	0.5
7/20	8	0	2	0	0	0	0	0	0	10	0.7
7/21	6	0	1	0	0	0	0	0	0	7	0.8
7/22	10	1	6	1	0	0	0	0	0	18	1.1
7/23	11	3	0	0	0	0	0	0	0	14	1.4
7/24	19	4	5	0	0	0	1	0	1	30	1.9
7/25	13	6	11	1	0	1	0	0	2	34	2.5
7/26	21	5	11	0	0	0	1	0	1	39	3.1
7/27	23	8	8	0	1	0	0	1	1	42	3.8
7/28	16	11	5	7	0	10	0	0	0	49	4.7
7/29	10	7	13	8	0	5	1	0	0	44	5.4
7/30	14	11	5	0	0	0	4	0	1	35	6.0
7/31	62	13	12	0	0	0	2	0	1	90	7.6
8/01	68	14	8	0	0	0	1	0	3	94	9.2
8/02	51	16	5	0	0	1	3	1	0	77	10.5
8/03	41	40	15	0	2	0	8	0	3	109	12.4
8/04	64	57	29	2	0	0	4	0	2	158	15.1
8/05	91	57	38	1	0	0	4	0	2	193	18.4
8/06	103	25	24	1	0	0	14	0	2	169	21.3
8/07	101	15	14	3	1	0	7	0	3	144	23.8
8/08	52	17	18	2	0	0	9	0	2	100	25.5
8/09	40	20	18	0	1	1	16	0	1	97	27.2
8/10	68	34	25	7	1	1	11	0	2	149	29.8
8/11	107	48	15	6	0	2	8	1	3	190	33.0
8/12	128	55	20	11	2	0	9	0	0	225	36.9
8/13	134	75	2	15	1	0	8	0	1	236	41.0
8/14	201	63	50	11	0	9	4	0	2	340	46.8
8/15	101	32	37	10	2	4	9	0	6	201	50.2
8/16	137	25	41	8	0	1	15	0	4	231	54.2
8/17	132	31	29	1	0	0	4	1	4	202	57.7
8/18	72	8	32	6	0	0	10	0	2	130	59.9
8/19	43	6	12	0	0	0	16	0	0	77	61.2
8/20	73	3	22	2	0	0	15	0	0	115	63.2
8/21	51	5	8	1	0	1	16	0	0	82	64.6
8/22	51	12	10	3	1	0	19	0	0	96	66.3

-continued-

Appendix A4.–Page 3 of 3.

Date	Right Bank #1 Tagged	Left Bank Tagged	Right Bank #2 Tagged	Right Bank #1 Untagged	Left Bank Untagged	Right Bank #2 Untagged	Gillnet Tagged	Gillnet Untagged	Recaps	Total Catch	%Cum. Catch
8/27	23	21	6	3	0	0	9	0	2	64	71.7
8/28	65	30	8	1	0	0	19	0	4	127	73.9
8/29	144	43	34	3	1	3	10	0	5	243	78.1
8/30	98	60	43	4	0	0	10	1	4	220	81.9
8/31	111	53	35	4	1	1	8	0	7	220	85.7
9/1	33	16	14	1	0	0	2	0	2	68	86.8
9/2	52	13	21	2	0	0	6	0	2	96	88.5
9/3	29	19	20	0	0	0	6	0	0	74	89.7
9/4	42	31	30	1	0	1	6	0	3	114	91.7
9/5	32	25	19	1	1	0	7	0	3	88	93.2
9/6	48	37	22	0	0	1	8	0	2	118	95.2
9/7	50	37	30	4	1	2	3	0	4	131	97.5
9/8	49	16	21	4	1	1	8	0	4	104	99.3
9/9	24	9	8	0	0	0	0	0	1	42	100.0
Total	3,052	1,198	892	141	18	45	370	7	96	5,819	

APPENDIX B.

Appendix B1.–Tags observed and recovered by date at the Takotna River weir, 2005.

	Chum		Sockeye		Coho		Chinook	
Date	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed
6/10	0	0	0	0	0	0	0	0
6/11	0	0	0	0	0	0	0	0
6/12	0	0	0	0	0	0	0	0
6/13	0	0	0	0	0	0	0	0
6/14	0	0	0	0	0	0	0	0
6/15	0	0	0	0	0	0	0	0
6/16	0	0	0	0	0	0	0	0
6/17	0	0	0	0	0	0	0	0
6/18	0	0	0	0	0	0	0	0
6/19	0	0	0	0	0	0	0	0
6/20	0	0	0	0	0	0	0	0
6/21	0	0	0	0	0	0	0	0
6/22	0	0	0	0	0	0	0	0
6/23	0	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	0	0
6/25	0	0	0	0	0	0	0	0
6/26	0	0	0	0	0	0	0	0
6/27	0	0	0	0	0	0	0	0
6/28	0	0	0	0	0	0	0	0
6/29	0	0	0	0	0	0	0	0
6/30	0	0	0	0	0	0	0	0
7/01	0	0	0	0	0	0	0	0
7/02	0	0	0	0	0	0	0	0
7/03	0	0	0	0	0	0	0	0
7/04	0	0	0	0	0	0	0	0
7/05	1	0	0	0	0	0	0	0
7/06	0	0	0	0	0	0	0	0
7/07	0	0	0	0	0	0	0	0
7/08	0	0	0	0	0	0	1	0
7/09	0	0	0	0	0	0	1	0
7/10	0	0	0	0	0	0	0	0
7/11	0	0	0	0	0	0	0	0
7/12	0	0	0	0	0	0	0	0
7/13	0	0	0	0	0	0	0	0
7/14	0	0	0	0	0	0	0	0
7/15	0	0	0	0	0	0	0	0
7/16	0	0	0	0	0	0	1	0
7/17	1	0	0	0	0	0	0	0
7/18	2	0	0	0	0	0	0	0
7/19	1	0	0	0	0	0	0	0
7/20	0	0	0	0	0	0	0	0
7/21	0	0	0	0	0	0	0	0
7/22	1	0	0	0	0	0	0	0
7/23	0	0	0	0	0	0	0	0
7/24	0	0	0	0	0	0	0	0
7/25	0	0	0	0	0	0	0	0
7/26	0	0	0	0	0	0	0	0
7/27	0	0	0	0	0	0	0	0
7/28	0	0	0	0	0	0	0	0
7/29	0	0	0	0	0	0	0	0
7/30	0	0	0	0	0	0	0	0
7/31	0	0	0	0	0	0	0	0

-continued-

Appendix B1.–Page 2 of 2.

	Chum		Sockeye		Coho		Chinook	
Date	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed
8/01	0	0	0	0	0	0	0	0
8/02	0	0	0	0	0	0	0	0
8/03	0	0	0	0	0	0	0	0
8/04	0	0	0	0	0	0	0	0
8/05	0	0	0	0	0	0	0	0
8/06	0	0	0	0	0	0	0	0
8/07	0	0	0	0	0	0	0	0
8/08	0	0	0	0	0	0	0	0
8/09	0	0	0	0	0	0	0	0
8/10	0	0	0	0	0	0	0	0
8/11	0	0	0	0	0	0	0	0
8/12	0	0	0	0	0	0	0	0
8/13	0	0	0	0	0	0	0	0
8/14	0	0	0	0	0	0	0	0
8/15	0	0	0	0	0	0	0	0
8/16	0	0	0	0	0	0	0	0
8/17	0	0	0	0	0	0	0	0
8/18	0	0	0	0	0	0	0	0
8/19	0	0	0	0	0	0	0	0
8/20	0	0	0	0	0	0	0	0
8/21	0	0	0	0	0	0	0	0
8/22	0	0	0	0	1	0	0	0
8/23	0	0	0	0	1	0	0	0
8/24	0	0	0	0	2	0	0	0
8/25	0	0	0	0	2	0	0	0
8/26	0	0	0	0	0	0	0	0
8/27	0	0	0	0	0	0	0	0
8/28	0	0	1	0	0	0	0	0
8/29	0	0	0	0	0	0	0	0
8/30	0	0	0	0	0	0	0	0
8/31	0	0	1	0	0	0	0	0
9/01	0	0	0	0	0	0	0	0
9/02	0	0	0	0	0	0	0	0
9/03	0	0	0	0	1	0	0	0
9/04	0	0	0	0	2	0	0	0
9/05	0	0	0	0	0	0	0	0
9/06	0	0	0	0	1	0	0	0
9/07	0	0	0	0	0	1	0	0
9/08	0	0	0	0	0	0	0	0
9/09	0	0	0	0	0	0	0	0
9/10	0	0	0	0	0	0	0	0
9/11	0	0	0	0	1	0	0	0
9/12	0	0	0	0	1	0	0	0
9/13	0	0	0	0	0	0	0	0
9/14	0	0	0	0	0	0	0	0
9/15	0	0	0	0	0	0	0	0
9/16	0	0	0	0	2	0	0	0
9/17	0	0	0	0	0	0	0	0
9/18	0	0	0	0	0	0	0	0
9/19	0	0	0	0	0	0	0	0
9/20	0	0	0	0	0	0	0	0
Subtotal	6	0	2	0	14	1	3	0
Total [a]	6		2		15		3	

[a] Total observed and recovered.

Appendix B2.–Tags recovered and observed by date at the Kogrukluk River weir, 2005.

	Chum		Sockeye		Coho		Chinook	
Date	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed
6/22	0	0	0	0	0	0	0	0
6/23	0	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	0	0
6/25	0	0	0	0	0	0	0	0
6/26	0	0	0	0	0	0	0	0
6/27	0	0	0	0	0	0	0	0
6/28	0	0	0	0	0	0	0	0
6/29	0	0	0	0	0	0	0	0
6/30	0	0	0	0	0	0	0	0
7/01	0	0	0	0	0	0	0	0
7/02	0	0	0	0	0	0	6	0
7/03	2	0	0	0	0	0	5	0
7/04	1	0	0	0	0	0	1	0
7/05	2	0	4	0	0	0	3	1
7/06	3	0	3	0	0	0	3	0
7/07	5	0	6	0	0	0	5	0
7/08	3	1	2	0	0	0	2	0
7/09	4	1	7	1	0	0	4	1
7/10	6	0	2	0	0	0	4	0
7/11	8	0	2	0	0	0	4	0
7/12	4	0	10	0	0	0	5	0
7/13	6	0	7	0	0	0	2	0
7/14	5	1	7	0	0	0	4	0
7/15	4	1	9	2	0	0	2	1
7/16	17	1	10	3	0	0	8	0
7/17	14	0	10	0	0	0	7	0
7/18	6	1	12	0	0	0	4	0
7/19	15	0	6	1	0	0	2	0
7/20	13	0	5	0	0	0	1	0
7/21	18	1	21	1	0	0	4	1
7/22	6	0	6	0	0	0	3	0
7/23	9	0	11	0	0	0	2	0
7/24	10	1	5	1	0	0	0	0
7/25	2	1	6	0	0	0	6	0
7/26	1	0	1	2	0	0	2	0
7/27	5	0	7	0	0	0	3	0
7/28	2	0	9	1	0	0	2	0
7/29	0	0	5	1	0	0	0	0
7/30	2	0	4	0	0	0	0	0
7/31	1	0	5	0	0	0	1	0
8/01	0	0	6	0	0	0	1	0
8/02	0	0	1	0	0	0	0	0
8/03	0	0	4	0	0	0	1	0
8/04	0	0	3	0	0	0	0	0
8/05	0	0	5	1	0	0	0	0
8/06	0	0	0	0	0	0	0	0
8/07	1	0	0	0	0	0	0	0
8/08	0	0	0	0	0	0	0	0
8/09	0	0	0	0	0	0	0	0
8/10	0	0	3	0	0	0	0	0

-continued-

Appendix B2.–Page 2 of 2.

	Chum		Sockeye		Coho		Chinook	
Date	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed
8/11	0	0	0	0	0	0	0	0
8/12	0	0	1	0	0	0	0	0
8/13	0	0	2	0	0	0	0	0
8/14	0	0	0	0	0	0	0	0
8/15	0	0	0	0	0	0	0	0
8/16	0	0	0	1	0	0	0	0
8/17	0	0	0	0	0	0	0	0
8/18	0	0	0	0	0	1	0	1
8/19	0	0	0	0	0	2	0	0
8/20	0	0	0	0	1	0	0	0
8/21	0	0	1	0	2	0	0	0
8/22	0	0	0	0	0	0	0	0
8/23	0	0	2	0	1	0	0	0
8/24	0	0	1	0	8	0	0	0
8/25	0	0	0	1	4	0	0	0
8/26	0	0	1	0	3	0	0	0
8/27	0	0	0	0	0	0	0	0
8/28	0	0	0	0	4	0	0	0
8/29	0	0	0	0	4	0	0	0
8/30	0	0	0	0	5	0	0	0
8/31	0	0	0	0	5	0	0	0
9/01	0	0	0	0	2	0	0	0
9/02	0	0	0	0	0	0	0	0
9/03	0	0	1	0	5	0	0	0
9/04	0	0	1	0	22	1	0	0
9/05	0	0	0	0	10	0	0	0
9/06	0	0	0	0	9	0	0	0
9/07	0	0	0	0	14	2	1	0
9/08	0	0	0	0	8	0	0	0
9/09	0	0	0	0	5	1	0	0
9/10	0	0	0	0	13	0	0	0
9/11	0	0	0	0	17	0	0	0
9/12	0	0	0	0	15	1	0	0
9/13	0	0	0	0	13	0	1	0
9/14	1	0	0	0	10	0	0	0
9/15	0	0	0	0	12	0	0	0
9/16								
9/17								
9/18								
9/19								
9/20	0	0	0	0	3	0	0	0
9/21	0	0	0	0	1	0	0	0
9/22	0	0	0	0	4	0	0	0
9/23	0	0	0	0	0	0	0	0
9/24	0	0	0	0	0	0	0	0
Subtotal	176	9	214	16	200	8	99	5
Total [a]	185		230		208		104	

Note: Days without data represent days that the weir was not operational.

[a] Total observed and recovered.

Appendix B3.–Tags observed and recovered by date at the Tatlawiksuk River weir, 2005.

	Chum		Sockeye		Coho		Chinook	
Date	Tags Recovered (Observed)	Tags Observed	Tags Recovered (Observed)	Tags Observed	Tags Recovered (Observed)	Tags Observed	Tags Recovered (Observed)	Tags Observed
6/15	0	0	0	0	0	0	0	0
6/16	0	0	0	0	0	0	0	0
6/17	0	0	0	0	0	0	0	0
6/18	0	0	0	0	0	0	0	0
6/19	0	0	0	0	0	0	0	0
6/20	0	0	0	0	0	0	0	0
6/21	0	0	0	0	0	0	0	0
6/22	0	0	0	0	0	0	0	0
6/23	0	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	0	0
6/25	0	0	0	0	0	0	0	0
6/26	0	0	0	0	0	0	0	0
6/27	0	0	0	0	0	0	1	0
6/28	0	0	0	0	0	0	0	0
6/29	0	0	0	0	0	0	0	0
6/30	1	0	0	0	0	0	0	0
7/01	0	0	0	0	0	0	0	0
7/02	2	0	0	0	0	0	0	0
7/03	3	0	0	0	0	0	6	0
7/04	3	0	0	0	0	0	0	0
7/05	0	0	0	0	0	0	1	0
7/06	3	0	0	0	0	0	0	0
7/07	6	0	0	0	0	0	1	0
7/08	8	0	0	0	0	0	1	0
7/09	7	1	0	0	0	0	0	0
7/10	4	1	0	0	0	0	2	0
7/11	10	0	0	0	0	0	0	0
7/12	6	0	0	0	0	0	0	0
7/13	10	0	0	0	0	0	1	0
7/14	10	1	0	0	0	0	1	0
7/15	15	0	0	0	0	0	0	0
7/16	9	1	0	0	0	0	0	0
7/17	4	0	0	0	0	0	0	0
7/18	7	1	0	0	0	0	0	0
7/19	3	0	0	0	0	0	1	0
7/20	7	0	0	0	0	0	0	0
7/21	6	1	0	0	0	0	0	0
7/22	2	3	0	0	0	0	0	0
7/23	3	0	0	0	0	0	0	0
7/24	7	0	0	0	0	0	0	0
7/25	1	0	1	0	0	0	1	0
7/26	2	0	0	0	0	0	0	0
7/27	2	0	0	0	0	0	0	0
7/28	2	0	0	0	0	0	0	0
7/29	2	0	0	0	0	0	0	0
7/30	2	0	1	0	0	0	0	0
7/31	2	0	0	0	0	0	0	0
8/01	1	0	0	0	0	0	0	0
8/02	2	0	0	0	0	0	0	0
8/03	1	0	1	0	0	0	0	0
8/04	1	0	0	0	0	0	0	0
8/05	1	0	0	0	0	0	0	0
8/06	0	0	0	0	0	0	0	0

-continued-

Appendix B3.–Page 2 of 2.

	Chum		Sockeye		Coho		Chinook	
Date	Tags Recovered (Observed)	Tags Observed	Tags Recovered (Observed)	Tags Observed	Tags Recovered (Observed)	Tags Observed	Tags Recovered (Observed)	Tags Observed
8/07	0	0	0	0	0	0	0	0
8/08	0	0	0	0	0	0	0	0
8/09	1	0	0	0	0	0	0	0
8/10	1	0	0	0	0	0	0	0
8/11	0	0	0	0	0	0	0	0
8/12	0	0	0	0	0	0	0	0
8/13	1	0	0	0	0	0	0	0
8/14	2	0	0	0	0	0	0	0
8/15	0	0	0	0	1	0	0	0
8/16	0	0	0	0	0	0	0	0
8/17	0	0	0	0	0	0	0	0
8/18	0	0	0	0	0	0	0	0
8/19	0	0	0	0	0	0	0	0
8/20	0	0	0	0	0	0	0	0
8/21	0	0	0	0	0	0	0	0
8/22	0	0	0	0	1	0	0	0
8/23	0	0	0	0	3	0	0	0
8/24	0	0	0	0	5	0	0	0
8/25	0	0	0	0	0	0	0	0
8/26	0	0	0	0	0	1	0	0
8/27	0	0	0	0	3	0	0	0
8/28	0	0	0	0	1	0	0	0
8/29	0	0	0	0	2	0	0	0
8/30	0	0	0	0	0	0	0	0
8/31	0	0	0	0	3	0	0	0
9/01	0	0	0	0	0	0	0	0
9/02	0	0	0	0	1	0	0	0
9/03	0	0	0	0	0	0	0	0
9/04	0	0	0	0	1	0	0	0
9/05	0	0	0	0	4	0	0	0
9/06	0	0	0	0	1	0	0	0
9/07	0	0	0	0	2	0	0	0
9/08	0	0	0	0	0	0	0	0
9/09	0	0	0	0	4	0	0	0
9/10								
9/11								
9/12								
9/13								
9/14								
9/15								
9/16								
9/17								
9/18								
9/19								
9/20	0	0	0	0	1	0	0	0
9/21	0	0	0	0	0	0	0	0
9/22	0	0	0	0	0	0	0	0
Subtotal	160	9	3	0	33	1	16	0
Total [a]	169		3		32		16	

Note: Days without data represent days that the weir was not operational.

[a] Total observed and recovered.

Appendix B4.–Tags observed and recovered by date at the George River weir, 2005.

	Chum		Sockeye		Coho		Chinook	
Date	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed
6/21	1	0	0	0	0	0	0	0
6/22	0	0	0	0	0	0	0	1
6/23	0	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	1	0
6/25	1	0	0	0	0	0	0	0
6/26	0	0	0	0	0	0	0	0
6/27	0	0	0	0	0	0	0	0
6/28	0	0	0	0	0	0	0	0
6/29	0	0	0	0	0	0	1	1
6/30	0	0	0	0	0	0	1	0
7/01	0	0	0	0	0	0	1	0
7/02	0	0	0	0	0	0	0	0
7/03	3	0	0	0	0	0	1	0
7/04	3	0	0	0	0	0	2	0
7/05	2	0	0	0	0	0	0	0
7/06	6	1	0	0	0	0	0	0
7/07	6	0	0	0	0	0	0	0
7/08	2	0	0	0	0	0	0	0
7/09	2	1	0	0	0	0	0	0
7/10	7	0	0	0	0	0	0	0
7/11	6	0	0	0	0	0	0	0
7/12	8	0	0	0	0	0	0	0
7/13	4	1	0	0	0	0	1	0
7/14	8	0	0	0	0	0	0	0
7/15	10	0	0	0	0	0	0	0
7/16	12	0	0	0	0	0	0	0
7/17	9	1	0	0	0	0	0	0
7/18	7	0	0	0	0	0	0	0
7/19	5	0	0	0	0	0	0	0
7/20	5	0	0	0	0	0	0	0
7/21	8	0	0	0	0	0	0	0
7/22	6	0	2	0	0	0	0	0
7/23	5	0	0	0	0	0	0	0
7/24	2	0	0	0	0	0	0	0
7/25	5	1	0	0	0	0	0	0
7/26	11	0	0	0	0	0	1	0
7/27	4	1	0	0	0	0	1	0
7/28	7	0	0	0	0	0	0	0
7/29	7	0	0	0	0	0	0	0
7/30	5	1	0	0	0	0	0	0
7/31	12	1	0	0	0	0	0	0
8/01	7	0	1	0	0	0	0	0
8/02	8	0	0	0	0	0	0	0
8/03	7	0	1	0	0	0	0	0
8/04	4	0	0	0	0	0	0	0
8/05	1	0	0	0	0	0	0	0
8/06	1	0	0	0	0	0	0	0
8/07	5	0	1	0	0	0	0	0
8/08	7	2	0	0	0	0	0	0
8/09	1	2	0	0	0	0	0	0

-continued-

Appendix B4.–Page 2 of 2.

	Chum		Sockeye		Coho		Chinook	
Date	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed
8/10	1	3	0	0	0	1	0	0
8/11	2	2	0	0	0	0	0	0
8/12	6	3	0	0	0	0	0	0
8/13	5	3	0	0	0	0	0	0
8/14	2	2	1	0	0	0	0	0
8/15	2	0	0	0	0	0	0	0
8/16	1	0	0	0	0	0	0	0
8/17	0	4	1	0	0	1	0	0
8/18	0	0	0	0	0	0	0	0
8/19	0	0	0	0	1	0	0	0
8/20	2	0	0	0	0	0	0	0
8/21	0	0	0	0	0	0	0	0
8/22	1	0	1	0	0	0	0	0
8/23	1	1	2	0	1	0	0	0
8/24	0	0	0	1	0	0	0	0
8/25	0	0	0	0	1	0	0	0
8/26	1	0	1	0	3	0	0	0
8/27	1	0	0	0	0	0	0	0
8/28	2	0	0	0	0	0	0	0
8/29	0	0	1	0	0	0	0	0
8/30	2	0	1	0	2	0	1	0
8/31	1	0	0	0	0	0	0	0
9/01	1	0	1	0	0	0	0	0
9/02	3	0	0	0	0	0	0	0
9/03	3	0	0	0	0	0	0	0
9/04	1	2	1	1	7	1	0	0
9/05	2	0	0	0	10	0	0	0
9/06	3	0	0	0	12	0	0	0
9/07	1	0	0	0	8	2	0	0
9/08	1	0	0	0	5	0	0	0
9/09	1	0	0	0	7	1	0	0
9/10	2	0	0	0	7	0	0	0
9/11	0	0	0	0	0	0	0	0
9/12	0	0	0	0	1	0	0	0
9/13	0	0	0	0	0	0	0	0
9/14	1	0	0	0	3	0	0	0
9/15	1	1	0	0	7	0	0	0
9/16	1	0	0	0	5	0	0	0
9/17	0	0	0	0	0	0	0	0
9/18	0	0	0	0	0	0	0	0
9/19	0	0	0	0	0	0	0	0
9/20	0	0	0	0	0	0	0	0
Subtotal	271	33	15	2	80	6	11	2
Total [a]	295		17		83		13	

[a] Total observed and recovered.

Appendix B5.–Tags observed and recovered by date at the Aniak River sonar site, 2005.

	Chum		Sockeye		Coho		Chinook	
Date	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed
6/22								
6/23	0	0	0	0	0	0	0	0
6/24	0	0	0	0	0	0	0	0
6/25	1	0	0	0	0	0	0	0
6/26	0	0	0	0	0	0	0	0
6/27								
6/28								
6/29								
6/30	0	0	0	0	0	0	0	0
7/01	0	0	0	0	0	0	0	0
7/02	0	0	0	0	0	0	0	0
7/03								
7/04								
7/05								
7/06								
7/07								
7/08	1	0	0	0	0	0	0	0
7/09	0	0	0	0	0	0	0	0
7/10								
7/11								
7/12								
7/13								
7/14	0	0	0	0	0	0	0	0
7/15	0	0	0	0	0	0	0	0
7/16								
7/17	2	0	0	0	0	0	0	0
7/18								
7/19								
7/20	1	0	0	0	0	0	0	0
7/21	0	0	0	0	0	0	0	0
7/22								
7/23								
7/24								
7/25								
7/26	3	0	0	0	0	0	0	0
7/27	0	0	0	0	0	0	0	0
7/28	1	0	0	0	0	0	0	0
7/29	2	0	0	0	0	0	0	0
7/30								
7/31								
8/01								
8/02								
8/03								
8/04	0	0	0	0	0	0	0	0
8/05	3	0	0	0	0	0	0	0
8/06								
8/07								
8/08								
8/09								
8/10								

-continued-

Appendix B5.–Page 2 of 2.

	Chum		Sockeye		Coho		Chinook	
Date	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed	Tags Recovered	Tags Observed
8/11								
8/12								
8/13								
8/14								
8/15								
8/16	4	0	0	0	0	0	0	0
8/17								
8/18								
8/19	1	0	0	0	0	0	0	0
8/20	1	0	0	0	0	0	0	0
8/21								
8/22								
8/23								
8/24								
8/25								
8/26	0	0	0	0	0	0	0	0
8/27								
8/28								
8/29	0	0	0	0	0	0	0	0
8/30								
8/31								
9/01	0	0	0	0	0	0	0	0
9/02								
9/03								
9/04								
9/05								
9/06	0	0	0	0	0	0	0	0
9/07	0	0	0	0	0	0	0	0
9/08								
9/09								
9/10								
9/11								
9/12								
9/13								
9/14								
9/15								
9/16								
9/17								
9/18								
9/19								
9/20								
9/21								
9/22								
9/23								
9/24	0	0	0	0	0	0	0	0
Subtotal	20	0	0	0	0	0	0	0
Total [a]	20		0		0		0	

Note: Days without data represent days that the weir was not operational.

[a] Total observed and recovered.

APPENDIX C.

Appendix C1.–Number of recovered tags from Chinook salmon by subsistence, commercial, and sport fishing, at locations downstream and upstream from the Kalskag tagging site on the Kuskokwim River, 2005.

Approximate Recapture Location	Fishery Type				
	Subsistence	Commercial	Sport	Found	Total [a]
50rkm<					
Chuathbaluk	2	0	0	0	2
Napaimiute	1	0	0	0	1
Crooked Cr.	6	0	0	0	6
Sleetmute	1	0	0	0	1
Red Devil	2	0	0	0	2
Holitna R.	1	0	0	0	1
Swift R.	5	0	0	0	5
Takotna R.	1	0	1	0	2
Subtotal	19	0	1	0	20
-50rkm to 50rkm					
Lower Kalskag	3	0	0	0	3
Kalskag	4	2	0	0	6
Birchtree Xing	2	0	0	0	2
Aniak Vil.	2	0	1	0	3
Subtotal	11	2	1	0	14
<-50rkm					
Kwethluk Vil.	1	0	0	0	1
Tuluksak Vil.	1	0	0	0	1
Subtotal	2	0	0	0	2
Total [b]	32	2	2	0	36

[a] Total number of tags recovered in each recovery community.

[b] Total number of tags recovered by fishery type.

Appendix C2.–Number of recovered tags from sockeye salmon by subsistence, commercial, and sport fishing, at locations downstream and upstream from the Kalskag tagging site on the Kuskokwim River, 2005.

Approximate Recovery Location	Fishery Type				
	Subsistence	Commercial	Sport	Found	Total [a]
50rkm<					
Aniak R. Sonar	1	0	0	0	1
Sleetmute	6	0	0	0	6
Red Devil	1	0	1	0	2
Vreeland Cr.	1	0	1	0	2
Holitna R.	5	0	0	0	5
Crooked Cr.	1	0	0	0	1
Chuathbaluk	1	0	0	0	1
Telaquana Lk.	0	0	0	4	4
Subtotal	16	0	2	4	22
-50rkm to 50rkm					
Lower Kalskag	6	0	0	0	6
Kalskag	3	1	0	0	4
Birchtree Xing	3	0	0	0	3
Aniak Vil.	9	0	1	1	11
Subtotal	21	1	1	1	24
<-50rkm					
Tuntatuliak	0	2	0	0	2
Johnson R.	1	3	0	0	4
Napakiak	1	2	0	0	3
Napaskiak	3	1	0	0	4
Oscarville	0	1	0	0	1
Bethel	2	8	0	0	10
Akiak	3	2	0	0	5
Akiachak	1	2	0	0	3
Kwethluk Vil.	0	1	0	0	1
Kisaralik R.	0	0	0	1	1
Tuluksak Vil.	2	1	0	0	3
Bogus Cr.	0	1	0	0	1
Subtotal	13	24	0	1	38
Total [b]	50	25	3	6	84

[a] Total number of tags recovered in each recovery community.

[b] Total number of tags recovered by fishery type.

Appendix C3.–Number of recovered tags from chum salmon by subsistence, commercial, and sport fishing, at locations downstream and upstream from the Kalskag tagging site on the Kuskokwim River, 2005.

Approximate Recovery Location	Fishery Type				
	Subsistence	Commercial	Sport	Found	Total [a]
50rkm<					
Aniak R. Sonar	0	0	6	1	7
Kolmakof R.	1	0	0	1	2
Chuathbaluk	0	0	0	1	1
Napaimiut	1	0	0	0	1
Oskawalik R.	1	0	0	22	23
Crooked Cr.	8	0	2	2	12
Eightmile	0	0	1	0	1
George R.	0	0	1	0	1
Holitna R.	1	0	5	2	8
Red Devil	2	0	1	0	3
Sleetmute	13	0	0	0	13
Swift R.	2	0	0	0	2
Stony River Vil.	7	0	0	0	7
Lime Village	2	0	0	0	2
Vreeland Cr.	4	0	0	0	4
Telaquana Lk.	0	0	0	4	4
Takotna R.	2	0	0	0	2
Subtotal	44	0	16	33	93
-50rkm to 50rkm					
Lower Kalskag	7	0	0	1	8
Kalskag	17	0	0	0	17
Aniak Vil.	32	2	9	11	54
Birchtree Xing	9	0	0	0	9
Aniak R.	1	0	2	3	6
Subtotal	66	2	11	15	94
<-50rkm					
Kasigiluk R.	0	1	0	0	1
Napakiak	0	1	0	0	1
Bethel	3	8	0	0	11
Akiak	4	8	1	0	13
Akiachak	5	6	0	0	11
Kwethluk Vil.	1	2	0	0	3
Napaskiak	3	4	0	0	7
Tuluksak Vil.	10	0	0	0	10
Bogus Cr.	1	0	0	0	1
Subtotal	27	30	1	0	58
Total [b]	137	32	28	48	245

[a] Total number of tags recovered in each recovery community.

[b] Total number of tags recovered by fishery type.

Appendix C4.–Number of recovered tags from coho salmon by subsistence, commercial, and sport fishing, at locations downstream and upstream from the Kalskag tagging site on the Kuskokwim River, 2005.

Approximate Recovery Location	Fishery Type				
	Subsistence	Commercial	Sport	Found	Total [a]
50rkm<					
Aniak R. Sonar	0	0	2	0	2
Oskawalik R.	0	0	0	4	4
Swift R.	0	0	2	0	2
Sleetmute	15	0	0	0	15
Telaquana Lk.	0	0	0	1	1
Crooked Cr.	1	0	0	0	1
Holitna R.	0	0	1	0	1
Takotna R.	1	0	0	1	2
Medra	0	0	0	1	1
Stony River	1	0	0	0	1
Subtotal	18	0	5	7	30
-50rkm to 50rkm					
Kalskag	38	0	0	0	38
Aniak Vil.	14	0	17	0	31
Aniak R.	7	0	0	0	7
Subtotal	59	0	17	0	76
<-50rkm					
Napaskiak	1	5	0	0	6
Kisaralik R.	0	0	3	0	3
Napakiak	1	2	0	0	3
Bethel	1	13	0	1	15
Akiak	2	5	0	0	7
Akiachak	2	16	0	0	18
Kwethluk Vil.	0	6	0	0	6
Bogus Cr.	2	1	0	0	3
Tuluksak Vil.	13	1	2	1	17
Subtotal	22	49	5	2	78
Total [b]	99	49	27	9	184

[a] Total number of tags recovered in each recovery community.

[b] Total number of tags recovered by fishery type.

APPENDIX D.

Appendix D1.–Escapement goal for Kuskokwim River Coho salmon (run reconstruction).

System: Kuskokwim River
Species: Coho salmon
Stock Unit: not applicable

Description of stock and escapement goals.

Regulatory Area:	Kuskokwim Area
Management Division:	Commercial Fisheries
Primary Fishery:	Commercial and subsistence
Previous Escapement Goal:	none
Escapement Goal Type:	not applicable
Recommended Escapement Goal:	none
Optimal Escapement Goal:	none
Inriver Goal:	none
Action Points:	none
Escapement Enumeration:	Reconstruction from weir and mark–recapture estimates

Summary:

Data Quality:	Fair
Data Type:	Weir counts, mark–recapture population estimates, harvests from commercial, subsistence, and sport fisheries.

Comments:

- Eek River is located essentially downstream of the commercial fishing area, so is excluded from the run reconstruction (Figure 1).
- Sources for 2001 to 2004 subsistence harvest Whitmore et al. (2005, *In prep*)
- Subsistence harvest is estimated for 2005 as the 2000–2004 average.
- Sport harvest is estimated for 2004–2005 as the 2001–2003 average.
- Source for escapement estimates upstream of Kalskag is Pawluk et al. (2006).
- 2005 Kwethluk River escapement is not a weir count but an expanded weir index count. Expansion is based on the historic relationship between Kuskokwim drainage weir counts.

-continued-

System: Kuskokwim River
Species: Coho salmon
Stock Unit: not applicable

Data available for analysis of escapement goals.

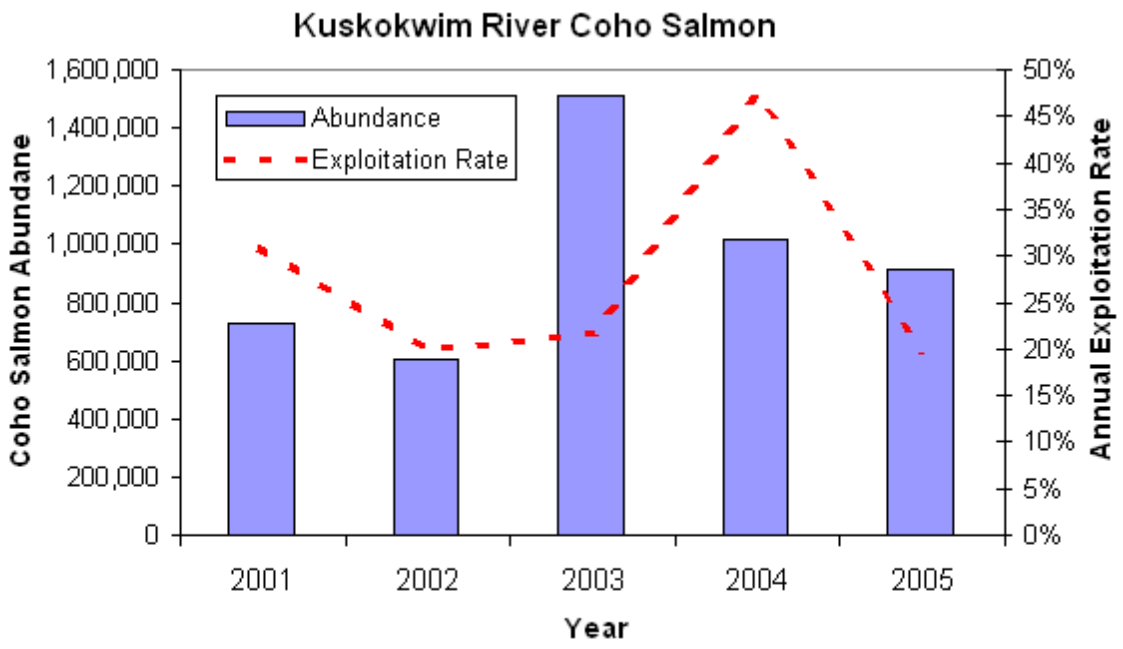
Run Component	Enumeration Method	2001	2002	2003	2004	2005
Harvest						
Subsistence		31,686	34,413	38,791	39,406	35,993 [a]
Commercial		192,998	83,463	283,833	433,809	142,319
Sport		1,204	2,030	3,244	4,996	2,870 [b]
Total Harvest		225,888	119,906	325,868	478,211	181,182
Escapement						
Kwethluk River	Weir	22,904	23,298	107,789	64,216	41,693 [d]
Kisaralik River	***Estimate***[c]	22,900	23,300	107,800	64,200	41,700
Tuluksak River	Weir	23,768	11,487	41,071	20,336	11,324
Mainstem Upstream of Kalskag	Mark–recapture	434,604	425,728	928,075	386,743	640,736
Total Escapement		504,176	483,813	1,184,735	535,495	735,453
Total Abundance Statistics						
Total Abundance		730,064	603,719	1,510,603	1,013,706	916,635
Annual Exploitation (Maximum)		31%	20%	22%	47%	20%

[a] Subsistence harvest is estimated for 2005 as the 2000–2004 average.
[b] Sport harvest is estimated for 2005 as the 2000–2004 average.
[c] Kwehluk River escapement in 2005 was estimated as an expanded weir index count.
[d] Coho salmon escapement into the Kisaralik is estimated to be equal to the Kwethluk River weir count.

-continued-

System: Kuskokwim River
Species: Coho salmon
Stock Unit: not applicable

Estimated total run abundance and exploitation rate by year.



-continued-

System: Kuskokwim River
Species: Coho salmon
Stock Unit: not applicable

Summary Statistics through:	2005	2005
	Abundance	Escapement
Number of Years	5	5
Average	954,945	688,734
Min	603,719	483,813
15th	679,526	496,031
25th	730,064	504,176
Median	916,635	535,495
75th	1,013,706	735,453
85th	1,212,465	915,166
Max	1,510,603	1,184,735
Contrast	3	2
Contrast Label		
Exploitation		
Current Minimum Goal	None	None
Suggested SEG Lower	None	None
Suggested SEG Upper	None	None